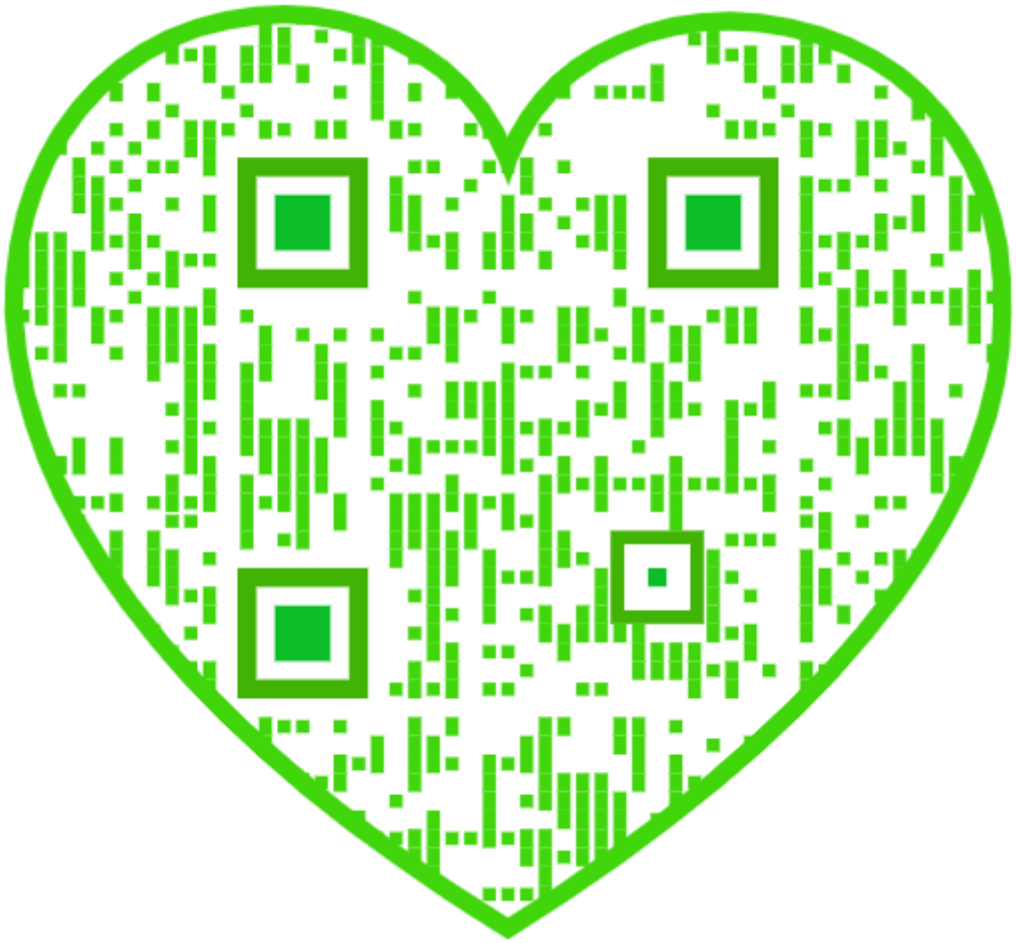

HAND-BOOK

OF

VETERINARY SURGERY

AND

OBSTETRICS

WITH CO-OPERATION

OF

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VOL. II.

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BY

DR. EUGEN FRÖHNER

THIRD EDITION

1905

GENERAL SURGERY

BY

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THE THIRD REVISED EDITION

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PREFACE TO THE FIRST EDITION.

In the following hand-book of veterinary surgery and obstetrics the general surgery, as well as the operative surgery, forms a separate, independent work. In a sense they serve as an introduction to the following third and fourth volumes of special surgery of the different organs.

Any text-book of general veterinary surgery must depend on the investigations and text-books of human medicine. While I have kept this point in view in the development of the following plan, I think I have clearly drawn the relations between the general surgery of man and animals. I also admit that in the writing of this book I have followed principally the plans which Billroth, and recently Tillman, have used in their text-books of human and general surgery.

The reader will readily note that the following work is not a mere compilation of the books mentioned on human medicine. In many particulars veterinary surgery, like pathology, pharmacology and therapy, has developed independent lines. Many chapters on human surgery have no connection with veterinary surgery; other divisions that are very important in human surgery are of little or no importance in veterinary science. Tuberculosis of the bones and joints, for example, belongs to one of the most important divisions of human surgery; in veterinary surgery it is practically never the occasion for surgical interference.

Conversely, actinomycosis and botryomycosis is of great importance in veterinary surgery, the latter is almost unknown in man. In man osteomyelitis is the most important form of inflammation of the bones; in the horse periostitis is the most important form. Erysipelas, so frequent in man, appears to be very rare in animals. It is obvious that resection of joints, as well as most amputations of limbs, cannot be employed on

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domestic animals. The aseptic method, which is so important in human surgery, seems to be of little importance in veterinary science because of purely external causes. Even bone-fractures present an entirely different surgical problem in large animals than in men. Firing, and the application of blisters for chronic inflammations of bones, tendons, and joints, are special surgical methods of veterinarians.

On the other hand, the following work is not a compendium of other surgical text-books on veterinary surgery. On the basis of many years of surgical and clinical activity, I think I have had sufficient experience to elucidate the following subject from my own point of view. In many chapters, namely, those on fractures and tumors, I was in a position to insert my own investigations. I was also careful to arrange the material purely from a veterinary standpoint, and only for the object of veterinary practice. On this basis the reader will find, for example, many references in this book to forensic veterinary science (age of wounds, fractures, fissures, muscular atrophy; curability or non-curability of bone-fractures in horses and cattle; abnormal fragility of bones; prophylaxis of bone-fractures, etc.). Foreign bodies, parasites, and congenital new-formations, which are of great surgical importance, have been given special attention.

General surgery has numerous and important relations to general pathology and pathological anatomy. Unfortunately we have no text-book of general pathology in our veterinary literature. On the other hand we have recently come into the possession of a very important hand-book of veterinary pathological anatomy. I am under great obligations to this excellent book of Kitt's for valuable suggestions and information. General surgery is also closely related to anatomy. I have found a deficiency in the descriptions of tendon-sheaths and fasciæ in most veterinary text-books on anatomy; these are very important from a surgical standpoint, the descriptions are usually incomplete and indistinct. With reference to the relation of general surgery to bacteriology, it must be acknowledged that the latter has contributed largely to the problem of suppuration and inflammation, as well as to the combating of

these processes by means of antiseptics, from a standpoint of both scientific and practical surgery. On the other hand, one must not overestimate the importance of bacteriology to general surgery and overlook everything else for bacteria. Many surgical inflammations have nothing to do with bacteria ; this is especially true of the purely traumatic, aseptic inflammations of bones, joints, tendons, tendon-sheaths, and muscles. At suitable places I have considered it my duty to repeatedly refer to this obligation. From a diagnostic standpoint also, bacteriology should not be given too great weight in surgery. Pus-cocci, in particular, are of little practical diagnostic importance ; this is especially true where the candidate, unfortunately, is overenthusiastic concerning the significance of a bacteriological examination, to him the presence of pus-forming bacteria in pus from bones may form the principal evidence for the presence of a bone-fistula. The bacteriological confusions that have occurred concerning wound-erysipelas receive attention in the chapter on this subject.

There is no claim of completeness for the bibliography at the end of each chapter. My principal object was to divide the literature on human medicine from that of veterinary science and, above all, also to indicate to students the fundamental investigations that have been made in human medicine ; only the most important and recent works have been mentioned.

The book contains no illustrations. I am opposed to the usual custom in veterinary science of appropriating illustrations from works on human medicine, either unchanged or specially modified. I maintain that it is not admissible.

KISSINGEN, August, 1896.

PREFACE TO THE THIRD EDITION.

The new, third edition of general surgery is improved and enlarged in many respects. The individual changes are as follows: The chapter on the etiology of tumors has been rewritten, and many additions have been made to the casuistry of this group; unfortunately the recent etiological works on tumors are largely speculations. The chapter on botryomycosis has been newly written to harmonize with the most recent investigations on this subject; there is hardly a doubt that in this wound infection we have to deal, not with staphylococci, but with an infectious disease sui generis. Regardless of the objections of critics, the chapter on tuberculosis has been retained and even enlarged; the motive for following this plan is explained in that chapter. I have supplemented the important chapter on chronic deforming arthritis with the results of recent investigations made in my clinic upon ringbones chronic gonitis, and omarthritis. This is also true of primary infectious osteomyelitis the occurrence of which in the horse, according to our recent investigations, can be no longer doubted. Recent investigations on myositis, neuritis, healing of fractures, necrosis bacilli, pseudo-edema bacilli, and foal-lameness have also been considered. On the subject of asepsis against antisepsis it may be definitely stated that now, even in human therapeutics, all have returned to antisepsis. In the first edition of this book I recommended antisepsis for the veterinary surgeon. Even for the disinfection of fresh wounds the application of pure carbolic acid, as well as the hot iron, has been recently recommended in human surgeries.

What a change within one decade!

Berlin, December, 1904.

PROF. DR. FRÖHNER.

TRANSLATOR'S PREFACE

The translation of the third edition of Fröhners "General Surgery" has been undertaken to supply a well classified presentation of the fundamental principles of surgery. It is hoped that it may assist the beginner in obtaining a clear perspective of the mass of surgical diseases with which he must come in contact.

That portion of the text dealing with bibliography has been omitted in the translation as it is practically unavailable to most English readers. Otherwise the text has been closely followed, no additions or other changes having been made.

The translator of this work is especially indebted to Professor David Stuart White who has rendered valuable assistance in reading the proof sheets. He is also indebted to Drs. A. D. Fitzgerald and James McI. Phillips for suggestions that have materially reduced the list of errors.

The translator wishes to express his gratitude to the firm of Taylor & Carpenter who have procured the authorization of this translation from the German publishers, assumed all financial responsibility, and shown every possible courtesy and assistance in furthering the progress of the work.

D. H. UDALL.

Columbus, Ohio, July, 1906.

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WOUNDS

I. GENERAL REMARKS CONCERNING THE NATURE, SYMPTOMS, AND CLASSIFICATION OF WOUNDS.

DEFINITION.—A wound, in a restricted sense, indicates any injury accompanied by a breach in the continuity of the skin or mucous membrane. Wounds may also be defined as open, hemorrhagic injuries, in contrast to lacerations and fractures which occur in the subcutaneous tissues and are not characterized by a breach in the continuity of the outer covering. The latter are closed to the presence of air, they are aseptic; that is, protected against the entrance of infectious irritants. Wounds, on the other hand, are open to the entrance of septic infection. The symptoms, course, prognosis, and treatment for both are, therefore, extremely variable. For this reason the open and subcutaneous injuries must be considered under separate headings.

An ulcer is differentiated from a wound by its tardiness in healing; it may be considered as a wound which will not heal.

GENERAL SYMPTOMS OF WOUNDS. The most important symptoms of fresh wounds are hemorrhage, pain, gaping, and disturbed function.

1. Hemorrhage varies according to the size and condition of the wounded vessels. One recognizes arterial, venous, parenchymatous, and capillary hemorrhage. Arterial hemorrhage is that which results from injuries to individual arteries, it spurts from the wound and is bright red in color. In venous hemorrhage large veins are involved, dark red blood flows from the peripheral ends in a continual stream as from a spring. Parenchymatous hemorrhage includes both

arterial and venous (mixed hemorrhage); the incised vessels are small, the blood is medium-red in color and flows from all portions of the wound similar to being squeezed from a sponge (tumors, swollen parts, muscle). Capillary hemorrhage follows slight injuries to the skin and mucous membrane, the blood flows in drops from the incised capillaries. As a rule, transverse wounds to vessels bleed more freely than those in a longitudinal direction because the gaping is greater (therefore an incision should be longitudinal when operating). In contused wounds the hemorrhage is occasionally very slight, the adventia constricts, the intima and media are retracted inwards, this results in mechanical closure of the vessel similar to that which occurs in torsion (ecraseur, emasculator). Penetrating wounds of large vessels usually close spontaneously (penetrating injury of the jugular from intravenous injection, an occasional penetrating injury to the carotid during the same operation). In previous anastomosis formation vessels bleed from both ends (carotid, large veins, thyroid gland).

The following symptoms are observed after severe hemorrhage: general anaemia which is especially characterized by paleness of the visible mucous membranes; coolness of the skin; as well as weak pulse and heart-beat which results from sinking of the blood pressure and weakness of the heart. Death from hemorrhage is further preceded by general weakness, tottering, vertigo, loss of consciousness, dyspnoea, dilitation of the pupils, disappearance of the corneal reflex action, involuntary urination and defecation, as well as convulsions. Death is more certain when the loss of blood is more than a third of the total amount. The The total amount of blood in a horse is equal to about one fifteenth of the total body weight. A horse weighing 450 kg., for example, (blood contents = 1/15 = 30 kg. or litres) dies after a loss of more than 10 kg. (litres) of blood. Loss of a third of the blood is followed by pronounced heart weakness and sinking of blood pressure, it is possible, however, for regeneration of the blood to take place from the parenchymatous fluids. Loss of a fourth of the total amount of blood is

only followed by decreased blood pressure (phlebotomy). Regeneration occurs through the absorption of water from the lymph of the tissues as well as from the fluid contents of the stomach and intestines (hydraemia); this is followed by an increase in the formation of the white blood corpuscles (leucocytosis); finally the red blood corpuscles gradually increase in number.

Injuries to large lymph vessels, joints, and tendon sheaths result in a discharge from the wound of lymph, synovia, and tendon-sheath fluid respectively; saliva is discharged from wounds to the salivary glands, salivary ducts, and esophagus; food or feces from perforating injuries to the stomach or intestines; milk from wounds to the udder; urine from lesions to the bladder or urethra. Hemorrhage is absent in corneal wounds.

2. Pain is due to cutting, bruising, or tearing the sensitive nerves. The so-called primary pain should be distinguished from secondary wound pain due to inflammation (nailing!). The pain of wounds is in direct proportion to the nerve supply of the affected tissues. Wounds of the skin, pododerm, periosteum, mucous membranes, cornea, or peripheral nerve endings are more painful than those of bone, cartilage and tendon, connective-tissue, or brain substance. The blunter the cutting instrument, and the slower the separation of the tissue, the greater the apparent pain (experience in operations). The sensitiveness of different animals varies according to the individual, age and sex, as well as the race and species. Many horses are very sensitive to neurectomy while others remain quiet during the operation. Many horses will stand without narcosis for trepanation and tracheotomy, as well as similar operations which require restraint, while others must be cast and restrained for operations that are far less painful. In general horses are more sensitive than cattle; dogs and cats more than horses. Horses that belong to the warm blooded races frequently show more sensitiveness than those of the cold blooded race (e. g. castration). Mares and stallions are usually more sensitive than geldings. The

following appear least sensitive: old horses, phlegmatic horses, and those affected with blind staggers.

In comparison to man, all domestic animals appear to be less sensitive to wounds. Many animals, after a severe injury, show a certain amount of resignation similar to man (trained dogs).

Complete insensibility follows deep narcosis (chloroform, cocaine); is present in dead tissues; and occurs after neurectomy, so that nail puncture in the hoof, for example, does not cause pain.

3. Gaping of wounds depends on the character of the incised tissue, as well as upon the direction of the wound. Gaping is most pronounced in those places where the skin is widely separated as a result of transverse muscle and tendon wounds.

4. Disturbed function occurs after wounds of the hoof, tendons, joints, and muscles, where it is characterized by lameness; wounds of the tongue result in deranged mastication; blindness may follow corneal wounds; wounds to the motor or sensory nerves may produce paralysis or anesthesia.

Very painful wounds in the horse result in a diminution or complete loss of appetite, this is frequently observed after horses have been operated under restraint. Genuine shock or wound shock (sudden paralysis of the vasomotor center with anemia of the mucous membranes, retardation and paralysis of the activity of the heart) is very rare in animals. Perforating abdominal wounds in the horse are frequently followed by colic (peritonitis). The following conditions frequently follow injuries to large nerve branches (neurectomy): stagnation edema, inflammatory conditions, ulcer formation and necrosis of the skin and pododerm, inflammation of the periosteum, bone, and joints, exungulation, atrophic changes, fractures, tendon ruptures, etc. (See chapter on diseases of the nerves.) Occasionally sudden death follows the introduction of air into the jugular vein (operation on shoulder abscess, phlebotomy); this is partly due to paralysis of the lungs (air emboli in the pulmonary capillaries), partly to paralysis of the heart (air in the chambers of the heart, air emboli in the

coronary arteries), partly to paralysis of the brain (air emboli in the capillaries of the brain). The aspiration of air into the abdominal cavity (gurgling sound), sometimes observed in the castration of stallions, is usually harmless. Finally, any wound may be followed by wound fever. Two forms are recognized, aseptic and septic wound fever. Aseptic fever is due to the resorption of degenerated blood products without the presence of bacteria. It is characterized by a slight elevation of temperature without severe disturbances of the general system (see chapter on wound fever). Septic fever, on the other hand, depends on the presence of specific infectious material which gains entrance to the wound and finally enters the blood stream. It is characterized by a marked elevation of temperature and severe derangement of the general system (see chapter on septicaemia and pyaemia).

CLASSIFICATION OF WOUNDS.—According to the causes wounds are classified as follows: incised, punctured, lacerated, contused, stab, shot wounds, and bites. In addition to wounds due to mechanical force one must consider injuries produced by chemical irritants (caustics), and thermic influences (burns, freezing), which are classified as caustic wounds, necrotic wounds, etc.

According to the condition of the wound they are classified as simple or non-contused (incised, punctured), and complicated or contused wounds (contusions, shot wounds, bites), wounds with and without loss of substance, flap or skin wounds, clean, unclean, (hair, dirt, dust), infected and poisoned, superficial, deep, and perforating or penetrating (abdominal cavity, thorax, joints), slight, severe, and fatal, fresh and old, hemorrhagic, suppurative, granulating and cicatrized wounds.

According to the seat and tissues involved they are classified as wounds of the head, thorax, throat, abdomen, skin, mucous membranes, muscles, bones, cartilage, joints, tendons, brain, cornea, stomach and intestines.

SHOCK IN ANIMALS.—Beck has observed one case of paralysis of the heart in a calf as a result of castration (Wochenschrift für Tier heilkunde. 1901). The animal bellowed very loud after the remova- of the first testicle (pain, fear, terror), collapsed and died immediately. The results of a post mortem were negative.

II. INCISED, PUNCTURED, CONTUSED, SHOT, LACERATED AND POISONED WOUNDS.

INCISED AND STAB WOUNDS.—These are due to injuries from surgical and ordinary knives, hay knives, hoof knives, butcher knives, case knives, shears, glass, pieces of iron, scythes, sickles, sabers, hatchets, etc. The characteristics of incised and thrust wounds consist in their straight direction, longitudinal form, as well as sharply defined, smooth, non-contused edges. Hemorrhage and retraction of edges are more pronounced than in the other forms. They are most often seen in horses, dogs, and cattle on various parts of the body, especially the limbs. According to depth they may be termed wounds of the skin, muscle, tendon, bones, and perforating wounds. The prognosis is favourable when the skin only is involved (suture). From a forensic standpoint it should be observed that many lacerated and contused wounds present edges similar to those of incised wounds (wire, sharp edge of the hoof).

PUNCTURED WOUNDS.—Punctured wounds are caused by manure forks, hay forks, nails, needles, pointed knives, and shears, lances, bayonets, harrows, splinters of wood, etc. Penetrating wounds in horses are most often due to manure and hay forks, as well as treads on nails and nailing. In the German Army the lance is a frequent cause of wounds on account of its wide use in the cavalry. During operations punctured wounds are often produced by means of the injection needle and the trochar (subcutaneous, intravenous, intraperitoneal, parenchymatous, intraocular, subconjunctival, subdural, intracranial, and even intracerebral injections, paracentesis thoracis, paracentesis, abdominis, harpooning the udder,

lumbar puncture). Punctured wounds are usually small, round, slightly hemorrhagic, and frequently lead to a fistulous canal. Perforations into joints, tendon sheaths, abdomen, thorax, eyes, etc., are common. Experience with injections and puncture has demonstrated that perforating wounds with sharp, clean instruments are harmless when they penetrate body cavities, the rumen, intestines, or a large blood vessel (jugular, carotid). All unclean objects, however, especially manure forks, unclean injection needles, old nails and harrow teeth, are liable to result in suppurative and septic infection (phlegmon, abscess, fistula formation, septicaemia, malignant edema, tetanus). Punctured wounds of the hoof (treading on nails, nailing) are frequently followed by tetanus.

CONTUSED WOUNDS.—Contused wounds are injuries caused by blunt objects, treads on the coronet, kicks, falls, collisions, running into objects, being run over, falling into holes, remaining in a recumbent position for a long time. Contused wounds are usually irregular in outline, possess jagged, unclean margins, are swollen, often have a loss of substance, and the contused tissue has a tendency to become necrosed. Occasionally hemorrhage is slight or fails entirely even in large contused wounds. One can differentiate superficial (excoriations, abrasions of the skin) and deep contusions, with and without loss of substance. (See chapter on contusions.)

LACERATED WOUNDS.—Lacerated wounds have some of the characteristics of incised wounds, they are also similar to contused wounds. They are caused by catching on or getting against hooks and nails, by sharp calks, running into wagons, machinery, etc. In horses they are most often seen on the head (false nostril, eyelid), on the thorax, buttocks, and posterior limbs. Special lacerated wounds are observed on the cornea in dogs (scratches from cats). Lacerated wounds are frequently in the form of flap wounds with angular formations, the margins of the wound may be regular or torn.

BITES.—Injuries caused by bites from dogs, horses and other animals present various characteristics; they may be punctured, contused or lacerated. They most frequently

occur in dogs and horses, seldom in cattle or other animals. Dog bites frequently result in severe phlegmon and complicated bone fractures; bites from horses in extensive necrosis of the skin on the sides and top of the neck (bites from animals standing in the same stall at night.)

POISONED WOUNDS.—Under this term are included injuries, especially to animals at pasture and hunting dogs, due to snake bites, bee and wasp stings, as well as infected wounds (rabies, anthrax, glanders, tetanus, septicaemia). With reference to the specific diseases thus produced one must consult text books on toxicology and infection (see chapter on wound infection diseases).

SHOT WOUNDS.—These belong to a special type of contused wounds and may be termed contused-lacerated wounds. They are characterized by an external opening with smooth, contused, angular or lacerated margins, a tubular shot canal, and an exit opening. When the latter fails it is termed a blind shot canal. When the shot is fired near the seat of injury the wound edges are burned. Superficial, long, gutter-shaped injuries of the skin are observed in furrowed gunshot wounds, contusions of the subcutaneous tissues without injury to the skin in gunshot contusions. Shots which perforate only beneath the skin are termed seton shots. In the bones there exists either a shot hole, that is, a round, somewhat tube-shaped shot wound without splintering of the bones, or comminuted fractures, that is, comminuted bone fractures with splintering and crushing of the bones; gun-shot contusions may be characterized by subcutaneous (simple) fractures. Unfortunately the literature of the German veterinary surgeries concerning gun shot wounds of horses in the earlier campaigns is worthless. According to the statistics of Jewsejenko collected in the Russo-Turkish War, from a total of 211 horses shot, 41 involved injuries of the bone (equal to 20 per cent). Healing frequently follows encapsulation, especially small shot, the latter seldom change position (wandering). When other bodies, however, enter with the bullet; namely, dirt, hair, portions of the covering, of the tugs, etc., there develops a suppurative or ichoric inflammation in the vicinity

of the shot canal. Shot wounds in horses are of importance in war; otherwise they are seldom observed (hunting dogs, cats).

GUNS AND PROJECTILES.—Shot injuries are produced, either by hand weapons (muskets, revolvers, pistols, small rifles), or cannon (shells, schrapnel, solid shot). Injuries caused by small shot are relatively slight, experience has demonstrated that in dogs they may heal without reaction. Injuries caused by musket balls are of more importance. While these balls were formerly manufactured from lead, were round, and tolerably large in diameter, the bullets of modern weapons of war, especially the eight millimeter gun, have a very small diameter (eight millimeters), a cylindrical, long form, as well as a very hard steel jacket over a core of lead. On account of the steel jacket and small diameter these bullets retain their form, while the earlier bullets were flattened or shattered when they came in contact with a bone, causing severe injuries, especially to the soft tissues. Modern projectiles exert, however, on hard bodies, especially bone, more active splintering force, and in addition to this an enormous penetration.

According to Kocher (Zur Lehre von den Schusswunden durch Kleincalibergeschosse. 1895) the force of modern projectiles is a blow in the direction of their flight (penetrating influence) on the one side, and an explosive effect (lateral impaction) on the other. As a result of the penetrating as well as the explosive effect the tissues involved are either lacerated or contused (explosive effect), or torn away (penetrating force). The slower the speed of the bullet, the lighter the explosive effect; penetration and explosive effect stand, therefore, in an inverse ratio to each other. If the projection force is less than the cohesion strength of the involved parts they become stretched and contused; when both are equal there exists a wedge-shaped perforation; if the force of the shot is greater than the cohesion of the parts the tissues are ruptured. In the first case the involved tissues are stretched; in the second they are pushed forward or to one side; in the third, lacerated. The degree of rupture depends on the diameter of the shot and the character of the tissues. An increase in the diameter of the missile is constantly occurring, this increases the surface of contact (oblique exit, change in the form of the shot). There exists a "reciprocal" influence between the target and the shot, in which the increased resistance of the target increases the explosive effect of the bullet, the explosive effect is also intensified by increasing the speed of the bullet. With increased resistance and explosive force there is a parallel diminution in the speed of the bullet (heating, deformation). A decrease in calibre and increase in the strength of the jacket results in decreased explosive force for elastic bodies, muscle and epiphyses of bone. Small calibre shots

from a short distance produce the following effect on cortical bone: laceration and contusion, splintering, and a bullet-shaped enlargement of the exit wound; large calibers produce very severe lacerations with enlargement of the entrance wound; with an increased velocity small bullets may produce the same results. Through international agreement a calibre of not more than six millimeters has been adopted, the bullets to be covered with a hard jacket, so that they do not become deformed by spreading, lacerations are prevented as much as possible and the prognosis from shot injuries very much improved.

The effect of the German eight millimeter gun on men and animals has been demonstrated by experimental investigations (Preussisches Kriegsministerium, v. Bruns, Kocher, Köhler and others). According to the investigations of Ellenberger and Baum (Berliner Archiv. 1893) on the horse it has a very variable action on different parts of the body at a distance of 250 to 600 meters.

1. The skin had, as a rule, a smooth-margined entrance wound which was usually smaller than the diameter of the bullet. The exit wound in the skin was always larger than the entrance wound. It was especially large when the shot had penetrated bones and the wound was torn by bone splinters.

2. Injuries to muscle vary according to their thickness. In smooth, stretched muscle the wounds are in the form of a slit, have smooth edges and are smaller than the diameter of the bullet; those in thick muscles are larger and more lacerated. The track of the bullet gradually enlarges, thereby increasing the laceration so that the exit wound is about double the size of the entrance wound and severely lacerated. Spent bullets (rebounding shots), as well as bullets which have passed through bone, produce severe tearing of the muscles. It is remarkable that in such cases vessels and nerves sometimes remain intact. Wounds in the fascia and connective tissue are in the form of a slit, frequently they are recognized with difficulty. Tendons are split with a slight retraction of the edges.

3. The epiphyses of the long bones frequently present a shot hole, extensive laceration is constant; the epiphysis is less frequently disunited. Shots in the diaphyses, on the other hand, are usually characterized by complete fracture, or at least accompanied by pronounced splintering; even with grazing shots the bones, as a rule, are completely comminuted. Grazing shots on the epiphyses lead to splintering. Shots in the center of short bones (carpus, tarsus, vertebrae) usually result in comminution. Flat bones usually present a shot hole with a round, small entrance wound, and a larger wound of exit which produces fissures and slight splintering. When the ribs are hit in the middle there exists a shot hole the size of the bullet's diameter, with longitudinal laceration and slight splintering at the

somewhat enlarged wound of exit. Grazing shots in the longitudinal direction of the body fracture the ribs. Transverse shots through the thorax penetrate the entire horse. When the bullet comes in contact with a rib at the entrance wound, one is also fractured at the wound of exit, it is a complete break in the continuity. On the bones of the skull there is produced a shot hole with splintering and sometimes crushing of the bones. The base of the skull is shattered. Gun shot wounds of the cartilage, on the other hand, are relatively small, they are often in the form of a smooth split.

4. The lungs are severely lacerated, the shot track usually contains splinters of bone, near the wound of exit the track increases in diameter. Also in the heart, one finds lacerated, flap, gaping wounds; seldom small round openings. In the small intestines there usually exists a small shot hole; in the large intestines, on the other hand, the wound is usually broad, flap-like and lacerated.

The French Weapons, according to Gabeau (Recueil vét. 1895) in experiments on the cadaver of the horse, result in severe injuries which are always of a complicated nature. At a distance of 100 to 200 meters all bullets penetrated the body of the horse. In the skin the entrance wounds are circular, as though penetrated with a punch; the skin itself is not changed. In soft parts the exit wound is oval in form; skin overlying bones on the other hand, is lacerated and notched. In muscles the wound canal is much larger than the diameter of the bullet; it contains fleshy, bloody masses and dilates in the direction of the exit wound. The muscle fibers appear to be torn in the direction of the rotation of the bullet. The aponeuroses and flat ligaments present linear wounds; tendon wounds are twice the width of the bullet, their fibers appear to be torn and lacerated. Long bones are broken or split and present oblique fractures with extensive splintering; short bones are crushed into splinters; the ribs present transverse fractures. The joints are comminuted, their bones are crushed to pulp; sometimes fragments of the bone are torn away and thrown several meters. The exit wound of joint shots is very large, the skin is torn in shreds. The lungs have cylindrical shot canals. In the liver the entrance wound is much larger than the bullet, the wound canal is very wide, the tissue of the liver is ground to pulp for a distance of three or four centimeters. In the stomach and intestines the entrance and exit wound are seemingly equal in size. In the hoof the entrance wound is hardly one mm. in diameter, almost invisible; the penetration of the hoof is complete.

The explosive effects of the so-called dum dum bullets is extremely active. These are small caliber bullets from which the steel point has been removed (expansive bullets). According to Walker (The Veter-

inarian. 1899) the entrance and exit wounds are small; the shot expands in the tissues and lacerates the bones and soft tissues.

III. ARREST OF HEMORRHAGE.

SPONTANEOUS ARREST OF HEMORRHAGE.—This is a cessation of hemorrhage of itself in contrast to artificial arrest by means of therapeutic agents. The so-called "stopping" of hemorrhage occurs in capillary and parenchymatous hemorrhage, as well as from that due to injuries to small arteries and veins.

The causes of spontaneous arrest of hemorrhage are, first of all, the small amount of blood, in addition one finds a retraction of the vascular walls with a narrowing of the lumina of the vessels. Coagulation of the exposed blood results in the formation of a thrombus which closes the opening and lies partly within the lumen of the blood vessel. Because of slight blood pressure in the capillaries and veins thrombi form in them in a very short time, thus arresting hemorrhage. In large vessels, on the other hand, especially in arteries, thrombus formation fails to occur, or exists only after the loss of a large amount of blood with resulting heart weakness and decrease of blood pressure, so that the blood coagulum is no longer forced away by the blood stream. After the loss of large quantities of blood it is made more coagulable by the addition of white blood corpuscles, thus aiding in the arrest of hemorrhage. This explains, for example, a fact which has been demonstrated by experiment, that stallions castrated without any precautions finally recover after severe hemorrhage. In general, as already remarked, the loss of blood must not exceed a third of the total amount, otherwise, there occurs a fatal paralysis of the heart and brain. Quantitative regeneration of the blood seems to take place rapidly through resorption of lymph from the tissues, as well as fluids from the stomach and intestines. The newly formed blood is, however, at first, very rich in water, the red blood corpuscles, on the other hand, are deficient, they are formed only after a long time.

The exact phenomena of thrombus formation are not fully understood. The principal factor in arrest of hemorrhage is the formation of a so-called white thrombus, which is composed of white blood corpuscles and the blood plates discovered by Bizzozero. This must be differentiated from the fibrinous coagulum which is the ordinary product of coagulation within the cadaver or outside the body. In contrast to the white thrombi, which to a certain extent are the result of physiological processes in normal living bodies, the so-called red thrombi are formed as a pathological process. The latter are made up of red blood corpuscles and fibrin and are formed during life in the vessels of animals suffering from septic affections, as well as from a general marasmus (marasmatic thrombi). These red thrombi are formed by a process of coagulation and death, similar to the formation of blood coagula in cadavers, they possess, therefore, an essentially different composition and importance. When both white and red thrombi exist at the same time they are termed a mixed thrombi.

The course of white thrombi varies according to the presence or absence of infectious material. When the thrombus remains free from infection, so-called organization occurs; that is, it develops into indurated, vascular, connective tissue, whereby the injured vessel contains a solid and permanent cicatricial obstruction. If infectious material gains entrance to the thrombus, however, there occurs a suppurative and ichoric softening of the thrombus with subsequent emboli.

1. The so-called organization of the thrombus consists in a replacement of the same by connective tissue. The cells of the thrombus itself do not undergo active division, the thrombus plays more of a passive role in that it is gradually pushed away by the newly formed tissue. The new connective tissue is produced by proliferation of the vascular epithelium. The endothelial cells of the intima of the vessels proliferate and are transformed into spindle-shaped and polymorphous formative cells, which advance towards the center of the thrombus, they penetrate and surround the same and are transformed later into fibrillar

connective-tissue cells; so that the thrombus, under the influence of the firm connective tissue, is finally pressed away and replaced. Vascularization of the thrombus occurs at the same time by means of a budding process from the vasa vasorum. In about four weeks the thrombus, when formed in small vessels, is made up of a cicatricial mass of connective tissue penetrated by capillaries; subsequently this becomes harder as a result of atrophy and retraction of the capillaries. Calcification or cretefaction of the thrombus is rare (so-called vein-stone or phlebolith).

The re-establishment of the circulation, which was broken by the thrombus, is made possible by the formation of a collateral circulation, in which the central and peripheral branches of the artery given off at the thrombus, as well as the vasa vasorum, are dilated. Occasionally the blood stream afterwards passes through the center of the thrombus, which becomes pervious; or it may pass through dilated cicatricial vessels.

2. Softening of the thrombus is due to the entrance of bacteria, which produce a suppurative liquefaction and ichoric disintegration of the thrombic mass and thereby the danger of embolic processes and general infection of the body (compare with the chapter on pyaemia and phlebitis).

DETERMINATION OF THE AGE OF A THROMBUS.—This is of importance to the veterinarian from a forensic standpoint (thrombus of the arteries of the limbs and pelvis in the horse). Unfortunately, exact experimental investigations on the horse are wanting. In general thrombus formation is more rapid in small vessels than in large; proceeds more rapidly in young animals than in old. Thrombus formation in chronic endarteritis in the horse seems to take place especially slow. In dogs it has been demonstrated experimentally that the thrombus is vascularized in from seven to fourteen days after injuries to small vessels, it is also composed of soft tissues; after three to five weeks a complete vascular cicatrix is present. Occasionally organization of the thrombus requires a much longer time. In old age calcified thrombi are observed. In general the age is determined by the consistence and color of the thrombus, which finally becomes hard and clear, as well as by the changes in the vascular walls.

ARTIFICIAL CONTROL OF HEMORRHAGE.—This consists of closure of the bleeding vessel either by means of pressure or

coagulation. The following are the most important methods:

1. Ligation of the bleeding vessel. The ligature is the surest means of controlling hemorrhage from large arteries and veins. The bleeding vessel is grasped with a good pincette and then ligated with silk. When the isolation is not complete the surrounding tissue is also included (ligature en masse) after having passed around the parts with a needle. If none of these methods are applicable on account of the depth of the bleeding vessel the spurting artery must be ligated at a centripetal point (ligation in the continuity), for example, the carotid is ligated after an injury to the internal carotid.

2. Compression of vessels by knots and bandages is indicated in capillary and parenchymatous hemorrhage. Occasionally strong pressure may be brought to bear on the bleeding vessel by means of a tampon in the wound. Momentary and provisional relief from hemorrhage may be attained through pressure with the finger or hand (digital compression), the application of an elastic bandage (Esmarch's bandage), or a rubber bandage (Martin's bandage); pressure should be applied between the wound and the heart. A special method employed by the veterinarian for the control of hemorrhage consists in the application of clamps for the castration of stallions. The formerly employed tourniquets (pad in the form of a girth) as well as the so-called acupressure are very seldom used at the present time.

3. Torsion of the bleeding vessels results in loosening and rolling up of the intima and media, as well as retraction of the adventia, thus closing the lumen of the injured vessel. Torsion is either applied to the bleeding vessel alone, when it is grasped with the pincette and twisted on its axis for a long time, or the surrounding soft tissues may be included (torsion of the spermatic cord). From many castrations of horses I am convinced that regular torsion of the spermatic cord is a surer means for the prevention of hemorrhage than either clamps or the ligature; from a standpoint of simplicity or asepsis torsion and clamps, especially the latter, are not preferable.

4. Heat in the form of a red hot iron or cautery is efficient in many forms of parenchymatous hemorrhage. It forms an eschar over the ends of the bleeding vessels which performs the function of an aseptic bandage (searing the tail after amputation). The application of cold (ice-cold water, spray of ether) is less effective. Its action is due to the contraction and narrowing of small vessels. Hot water is employed at a temperature of 45-50 C. as a styptic for parenchymatous hemorrhage of the uterus. Even steam at a temperature of 100–120° has been employed recently in the human family for persistent cases of uterine hemorrhage (vaporization of the uterus, so-called atmocausis and zestocausis).

5. The following therapeutic agents exert a styptic influence, active only in capillary and parenchymatous hemorrage: liquor ferri chloridi, concentrated or combined with collodion, with surgeons cotton or in aqueous solution. This causes coagulation of the blood with simultaneous constriction of the blood vessels. Other agents are alum, tannin, creolin, sugar of lead, nitrate of silver, oil of turpentine, gelatine (subcutaneous), ergot or hydrastis is employed to control hemorrhage that cannot be treated surgically.

HEMOPHILIA.—Hemophilia (blood disease) is a congenital tendency to hemorrhage (hemorrhagic diathesis) which presents the following characteristics in man: uncontrollable hemorrhage after very slight wounds. This disease also occurs in the horse (Köhne, Siedamgrotzky, Dreymann, Otto, Zschokke, and others). The following examples have been observed: after enlarging castration wounds, after the removal of setons, after splitting fistulous canals, after the extraction of teeth in dogs; hemorrhage has continued for hours and days regardless of all preventatives. Not all reported observations from veterinary sources are free from exception; I have never seen a case of hemophilia in the dog or horse. The real cause is unknown (abnormal condition of the blood? failure to coagulate? deranged nourishment of the vascular walls?). According to Schindelka many descendants of the thoroughbred stallion "Gunnersbury" suffer from a hemorrhagic diatheses (epistaxis) (transmission as in man?).

IV. ANATOMICAL CHANGES IN WOUND HEALING.

KINDS OF WOUND HEALING.—The anatomical changes in the healing of wounds, which have been demonstrated by the exhaustive investigations of Thiersch, are extremely variable. They depend upon the following conditions: whether the wound is clean or infected, sutured or open, incised or contused, with or without loss of substance. The following forms of wound healing may be recognized:

1. Healing by first intention.
2. Healing by second intention.
3. Healing by third intention.
4. Healing under scab.
5. Abnormal granulation and cicatrization

HEALING BY PRIMARY INTENTION.—Healing by first intention consists of a direct union of the margins of the wound through immediate agglutination without suppuration. Healing by primary union depends on the following conditions: fresh, non-infected (aseptic) wounds, fresh incised wounds with even margins and, when possible, without loss of substance; when infection has occurred careful disinfection must be employed (antiseptic treatment); the margins of the wound must be brought in close apposition by means of sutures; all foreign bodies (hair, dirt, blood, etc.) must be removed; application of an aseptic bandage. In the domestic animals these conditions are usually applicable only to operation wounds, and then only when possible to afford protection by means of a bandage.

Macroscopically healing by primary union first presents an agglutination of the edges of the wound with blood, afterwards a lymph-like plasmic fluid (so-called wound cement) exerts the same influence. The surface of the wound remains dry. About the second day the margins of the wound are slightly swollen, sensitive, and red. After about a week (four to eight days) definite union results with the formation of a small cicatrix. Microscopically one soon observes emigration of the white blood corpuscles from the neighboring blood vessels to the margins of the wound and to the wound

cement. This cellular infiltration of the wound with wandering white blood corpuscles is considered a process of inflammation. Wandering of the white blood corpuscles is due to a traumatic irritant (traumatic, aseptic inflammation) and is to be considered, therefore, as a reactive manifestation on the part of the injured tissue. According to recent investigations bacteria which gain entrance to a wound that heals by primary union are soon rendered harmless and partly resorbed; this is principally due to the bactericidal properties of the blood serum (antitoxins, alexins) which is one of the constituents of wound secretions. The infiltration of the wandering cells (leucocytes) in the wound cement and margins of the wound reaches its height on the third day; from that time they degenerate or return to the vessels.

The wandering cells take no part in the formation of the definitive cicatrix, a former erroneous supposition. The cicatricial tissue develops from the so-called fibroblasts; these are round cells which arise from the proliferation of the fixed (autochthonous) connective tissue cells and the endothelium of the vessels. The fibroblasts gradually enlarge; large epithelioid, as well as long, spindle, and club-shaped cells are formed; these are afterwards transformed into fibrillar, connective tissue cells when they form genuine cicatricial tissue. Simultaneously there occurs a budding process from the walls of the incised capillaries, new vessels are thus formed between the margins of the wound. The fibroblasts in combination with the newly formed vessels form the so-called germinal tissue (granulation tissue); this is a cellular and vascular new formation. After the transformation of the fibroblasts into connective tissue cells the granulation tissue contracts so that the newly formed vessels atrophy again; thus the formation of the genuine cicatricial tissue is complete. Finally the cicatricial tissue is completely covered by proliferations from the epidermal cells (rete Malpighi, epithelium

of the dermal glands) at the margins of the wound. This completes the process of healing by primary union.

HEALING BY SECOND INTENTION.—This mode of healing occurs with suppuration as a result of infection with ordinary pus cocci. It is characterized by the formation of an abundance of granulation tissue. One finds this form of healing in old wounds, wounds that have become infected, those that have not received aseptic treatment, contused wounds, wounds with a loss of substance, or those which cannot be sutured.

Macroscopically, within the first twenty-four hours the individual tissues and blood may be readily differentiated on the surface of the wound. A serous, lymphatic, reddish-yellow secretion is formed after one or two days, giving the surface of the wound a gelatinous appearance. From the second to the third day the surface of the wound presents a granular appearance (granulations), pus begins to form. During the course of the suppuration the necrosed tissue is sloughed off, the wound is "self-cleansing." Later, the granulating wound surface is gradually covered with epidermis from the margins of the wound, the newly-formed epidermis surrounds the margins of the granulations in the form of a light colored fringe. The granulation tissue contracts and is completely covered, there finally remains a broad, firm, tendonous cicatrix. The microscopic changes are identical with those which occur during healing by first intention. The only points of difference are that in healing by second intention infection takes place. The wound is irritated by bacteria and their products, which results in the formation of large quantities of granulation tissue, this being the product of a suppurative inflammation it furnishes a purulent exudate. Healing, therefore, requires a much longer time (two or more weeks). Cellular infiltration of the edges, formation of the fibroblasts, budding of

the capillaries, and transformation of the fibroblasts into connective tissue proceeds exactly as in healing by first intention. Further, suppuration does not form an absolutely necessary condition for healing by secondary union. The essential condition is the abundant formation of granulation tissue, which may occur without suppuration (aseptic granulations).

Granulation tissue formed during healing per secundam serves principally as a compensation for the loss of substance. In addition it forms an important protection against the entrance of infectious irritants into the blood stream. The entrances to the lymph streams are mechanically closed by the granulation tissue, the pus also contains bactericidal properties (pus serum, like blood serum ; pus corpuscles, like white blood corpuscles). This explains the long known surgical fact, that with the formation of granulation tissue the danger from general infection is greatly diminished after the third day. Experimental investigations upon sheep have also demonstrated that granulating wound surfaces are not permeable for anthrax bacilli or for the toxins of tetanus. The protective action of granulations is of great importance, therefore, in veterinary science, as healing by primary union is seldom attained. Above all, the granulations supply the loss of substance when healing by primary union is impossible. Many wounds cannot heal except through the formation of granulation tissue (wounds of the cartilage and cornea).

HEALING BY THIRD INTENTION.—This consists in the artificial union of wound surfaces that are already granulating and suppurative. It sometimes follows careful disinfection and exact suturing of suppurative granulations. Healing by third intention should not be confused with scarification and suturing of granulating wounds (same as healing per prima). Healing by third intention is of considerable importance in veterinary surgery as certain forms of purulent lacerated wounds may be brought to rapid healing by this method. This is especially true of

those about the head (false nostril), permanent union resulting in wounds a week or more old. Healing by third intention should always be given a trial, especially in the horse, when healing per prima cannot be expected from scarification of the wound surfaces.

HEALING UNDER AN ESCHAR.—This is a form of primary wound healing. The blood dries on the surface of the wound and leads to the formation of a protective coat. In small wounds cicatrization without suppuration takes place rapidly beneath the eschar, new epidermis is quickly replaced from the margins of the wound. In veterinary surgery this method of healing is of great importance as many wounds can be neither sutured nor bandaged, the dry scab taking the place of the latter. It may be applied artificially by means of a hot iron, production of a necrotic covering (wounds of the ear, tail, joints, extirpation of small tumors from the backs of dogs), or by the application of tannin, tannoform, glutol, amyloform, argentum nitricum or other disinfecting agents that produce an eschar.

ABNORMAL GRANULATION AND CICATRIZATION.—While the various forms of normal wound healing by the processes of granulation formation and cicatrization lead, as a rule, after more or less time, to the formation of a typical cicatrix, many wounds form an exception to this rule. The granulation and cicatricial process appears abnormal. This is true when foreign bodies or necrosed pieces of tissue remain in the wound, when there is great loss of substance, when continued infection or irritation occurs in fresh or healing wounds, when the injured animal is suffering from certain infectious diseases (see below).

1. Granulations are especially abnormal when the granulation tissue forms too rapidly and in large quantities; exuberant proliferations, fungus-like granulations (granuloma, caro luxurians, proud flesh). Excessive granulations are observed in treads on the coronet; fistulous withers or saddle galls when necrosed pieces of tissue are retained and act as a constant irritant to the part; in skin wounds on the flexor surfaces of the joints (carpus, tarsus)

when continually irritated by flexion and extension movements of the limbs; in muscle prolapse as a result of constriction and continued irritation of the exposed part after injury to the fascia of the limbs, in intensive suppurative infection. Other diseased forms are: erethistic granulations, that is, sensitive, dark-red, easily hemorrhagic, and very painful granulation tissue; atonic (torpid, asthenic) weak or deficient, as well as unequal granulation, and gangrenous degeneration of the granulation tissue (diphtheria of the granulations).

2. Cicatrization may become abnormal in various ways. Great loss of substance results in an incomplete cicatrix; suppurative decomposition in the formation of an ulcer or fistula. In horses there is frequently observed on the cicatrix an abundant accumulation of horny epidermal cells (horny cicatrix). Occasionally one observes a tumor-like proliferation of the cicatricial tissue (cicatricial keloid, cicatricial hypertrophy). This is seen in horses in the flexor regions of the fetlock and coronet (compare with chapter on keloids, under tumors). So-called painful or sensitive cicatrices (neurectomy, throat, shoulder) are rare in the horse. A cicatricial contracture occasionally results from extensive destruction of the skin, that is, cicatricial contraction of the neighboring skin leads to change in position of parts of the body (caput obstipum from contraction of the tissues of the neck; stilt-foot in necrosis of the skin on the posterior surface of the carpus and metacarpus; ectropium from extensive wounds of the eyelids).

The causes of atypical wound healing are both local and general. Under local causes are mechanical lesions of the tissues (contusions, constant irritation from foreign bodies, licking, rubbing, and movements); irritation of the wound through chemical irritants (antiseptics, decomposing secretions, necrosed particles of tissue); infection of the wound through specific inflammatory irritants (botryomyces fungi, glanders, necrosis bacillus), or by means of various other especially virulent, pus forming bacteria; deranged circulation (anaemia, hyperaemia, thrombosis). Neurectomy, as a local cause of deranged circula-

tion and nourishment, may influence normal wound healing (injuries to the hoof). General causes of disturbed wound healing are: febrile general diseases; chloroform (reduced activity of the white blood corpuscles; weakening of the activity of the heart); old age; general weakness and conditions of exhaustion; weak constitution; faulty breeding, care and food; diseases of the kidneys; hydraemia; cancerous cachexia; diabetis. Also the race and species, as well as the condition of the stable, temperature, season, climate, etc., all have an influence on the healing of wounds. Finally, many animals have idiosyncrasies which interfere with normal wound healing and favour the entrance and multiplication of infectious material. On the other hand, many animals appear to have congenital immunity against wound infection diseases; wounds on native born Algerian horses, for example, heal without suppuration and without treatment.

WOUND HEALING AND REGENERATIVE ABILITY OF DIFFERENT TISSUES.—1. Wound healing in the skin, pododerm and mucous membrane takes place according to the previously described methods. Regreneration is most rapid in the following tissues: epidermis, skin and pododerm (formation of horn), the epithelium of the mucous membranes, as well as the connective tissues.

2. Muscle wounds do not heal by regeneration of muscle fibers, but by means of a fibrillar, connective-tissue cicatrix. The regenerative ability of muscle is very slight. Proliferation and enlargement of the muscle cells occurs only in the vicinity of connective tissue cicatrices, as well as in small, superficial injuries to the muscle, even here the formation of new muscle fibers is limited.

3. Tendon wounds heal principally through proliferation of the cells of the tendon sheath, of the paratendineum, and the interfascicular connective tissue, the genuine tendon cells of the tendon stump also take part. The granulation tissue that results from this proliferation unites both ends of the tendon and gradually changes into genuine tendon tissue (compare with the chapter on rupture of tendons).

4. Wounds of the bone heal in the same manner as fractures, through ossification of the granulation tissue (callus); this is formed from the periosteum and bone marrow, as well as the bone itself (periostitis, osteomyelitis, and ostitis ossificans) (compare with chapter on healing of bone fractures).

5. Cartilage wounds that are covered with perichondrium (lateral cartilage, trachea, muscles of the ear) heal, similar to bone wounds, through proliferation of the perichondrium with the formation of a callus that is at first fibrous and afterwards ossified. The cartilage cells that fall directly into the cartilage wound undergo fatty degeneration. Synchronous with the proliferation of the perichondrium there occurs a multiplication of the neighboring cartilage cells with a new formation of cartilage tissue. In non-vascular articular cartilage, however, the relation is very different. Aseptic, clean, cartilage wounds in the joint never heal, they remain as a permanent defect. Infected, articular-cartilage wounds, on the other hand, heal completely. Severe irritation of the non-vascular tissue of the wound leads to the formation of granulations and a connective-tissue cicatrix. Afterwards the connective-tissue cicatrix may be even partly transformed to hyaline tissue.

6. The peripheral nerves, when injured, possess an extremely active regenerative ability. When a nerve suture is applied replacement takes place through new formation of nerve fibers from the old nerve fibers of the central stump; these new fibers grow into those of the peripheral stump. When the ends of the nerves, however, remain at least one centimeter apart (neurectomy) the peripheral portion of the incised nerve degenerates, while the central nerve stump anastomoses with neighboring nerves, in this manner the conductivity is again established. At the same time new nerve fibers sprout from the central stump, which fill in the defect between the ends, and extend along the course of the peripheral portion. In this manner the nerve is replaced, when degeneration was complete, or fusion may occur when the fibers are still intact (chemotatic influence of the products of degeneration of the old nerve fibers on the growing central nerve cylinder). As a result of constant irritation (neuritis) the central nerve end undergoes a new formation of nerve fibers and connective tissue, this results in a club-shaped swelling (neuroma).

7. In the brain and spinal-marrow—in contrast to the peripheral nerves—regeneration of nerve substance does not occur; there is a formation of connective-tissue cicatrix similar to that which occurs in regeneration of muscle.

8. In the non-vascular cornea healing of wounds is similar to that in vascular tissues. One first finds migration of white blood corpuscles from the neighboring conjunctiva and schlera, as well as a subsequent autochthonous cellular proliferation with the formation of fibroblasts and the successive transformation of these into fibrillar connective-tissue. The formation of new vessels in the cornea, however, does not take place in the corneal tissue, but proceeds from the margin of the sclera.

V. WOUND INFECTION DISEASES.

DEFINITION.—The term wound infection diseases or accidental wound diseases embraces the general surgery of a long list of affections due to wounds which depend on the entrance of microorganisms or their products (toxins). The bacteria gain entrance to the wounds by contact or through the air. They maintain local disease processes in the wound or some form of general derangement. In a narrow sense the most important wound infection diseases are: 1. Suppuration, 2. Phlegmon, 3. Abscess, 4. Wound Fever, 5. Septicaemia, 6. Pyaemia. The following diseases may also result from the wound: inflammation of the lymph vessels (lymphangitis), inflammation of the veins (phlebitis), as well as erysipelas. In a broader sense wound infection includes tetanus, glanders, rabies, botryomycosis, actinomycosis, tuberculosis, malignant edema, strangles, anthrax, black leg, and Wildseuche. The following includes a description of the wound diseases in the narrow sense.

1. SUPPURATION OF WOUNDS.

CAUSES.—Suppuration which accompanies healing by second intention is a product of inflammation caused by infection of the wound with pus cocci. The following have been found most often on bacteriological examination: staphylococcus and streptococcus (staphylomycosis, streptomycosis). The following are the most important pus forming bacteria:

a) Staphylococcus pyogenes aureus is the most frequent pus coccus in animals, especially the horse. They are in the form of small, round, non-motile cocci; arranged as lobules, clusters, or as diplococci; on potatoes, agar, and gelatine they form orange-yellow cultures. Experiments have demonstrated the fact that their action is due to the production of toxins which act as an irritant and produce inflammation. Subcutaneous injection of a pure culture usually results in the formation of an abscess; intra-abdominal

injection in fatal suppuration ; injection into the blood, pyaemia as well as ulcerative endocarditis. Repeated injections have resulted in the seemingly rapid formation of amyloid degenerations (liver, kidneys). Staphylococcus pyogenes aureus is especially common in circumscribed, localized suppuration, in pyaemia, and in the pyaemic form of foal lameness.

b) Staphylococcus pyogenes albus is less common. It is distinguished from the preceding form by its less virulent pathogenic action, and white, varnish-like cultures. According to some, it is the cause of moon blindness (?).

c) Staphylococcus pyogenes citreus is rare. It is characterized by the citron-yellow color of its cultures, otherwise it is identical with the preceding.

d) Streptococcus pyogenes is next in importance to staphylococcus pyogenes aureus. It forms cocci arranged in the form of a chain ; it does not grow on potatoes, on gelatine it forms very small white colonies. Streptococcus pyogenes is a special cause of progressive phlegmonous suppuration with subsequent septicaemia. It is found, therefore, in the septic form of foal lameness. It also appears to be identical with the streptococcus of erysipelas, strangles, contagious pleuro pneumonia, acute articular rheumatism, and petechial fever (?).

e) Bacillus pyogenes appears to be the most important cause of pus formation in cattle and swine ; see page 36.

f) Bacillus pyocyaneus—the bacillus of blue and green pus—forms small, slim, very motile bacilli. They frequently possess four to six flagella. Through the decomposition of albumen they produce a blue and yellowish-green coloring material (pyocyanin, pyoxanthin) similar to the bacilli of blue milk. Chemically this is closely related to anthracine, it also belongs to the benzol group, and colors the pus and bandage blue or greenish-yellow. While the coloring material is harmless, the bacilli and their toxins have a pathogenic action towards experimental animals, producing an

edematous and suppurative inflammation at the point of injection. Bacilli with red coloring material are also found in pus.

COLON BACILLUS.—The colon bacillus (Bacillus coli communis, Bacterium coli commune) is found in various varieties in the normal intestinal canal. It is present in many species and races, and is usually a harmless organism because its very poisonous toxins are neutralized in healthy animals by the action of the gall. Under certain unknown conditions the colon bacillus in the intestinal canal becomes highly virulent (calf diarrhoea, calf septicaemia, enteritis, peritonitis, cystitis, pyelonephritis, hepatic abscesses, endometritis, septicaemia puerperalis, polyarthritis and omphalo-phlebitis in the calf, malignant head catarrh in cattle, croupous enteritis in cats, as well as various other "colon bacilli" infections). In the subcutaneous connective-tissue it causes suppuration with more or less serious phlegmons (septic and gas phlegmon). It is alleged to be identical with Bacterium phlegmasiae uberis, bacillus foetidus, neapolitanus and lactus aerogenes.

The following microorganisms may also cause suppuration under certain conditions: actinomyces and botryomyces fungi; the bacillus of glanders; the streptococcus of strangles; the cocci of contagious pleuro pneumonia; the micrococcus pyogenes tenuis and tetragenes; the capsule coccus (diplococcus); the bacillus pyogenes foetidus; the staphylococcus cereus, albus, flavus; proteus vulgaris, and others. Finally, the courses of many infectious diseases; namely, suppurations of tuberculosis and actinomycosis are, frequently accompanied by mixed infections of ordinary pus bacteria. For further information on suppuration, in regard to pus bacteria found in individual domestic animals, as well as on the development of so-called aseptic inflammation (injections of oil of turpentine, sublimate, nitrate of silver) compare with the chapter on inflammation.

PROPERTIES OF PUS.—Under ordinary conditions pus forms a thick, creamy, yellowish or greenish, non-odorous, non-coagulable fluid (pus bonum et laudible). As a result of infection with bacteria which produce a colored secretion the pus may be green or blue, seldom yellow. Thin, mucous-like, frothy, odorous pus indicates the presence of decomposition as a result of colonization of septic bacteria in the wound. The condition and quantity of the pus varies with the size and age of the wound, the blood supply and consistence of the wound, the species, quantity and virulence of the bacteria, temperature and season, climate, breed, etc. Pus from the horse is usually yellowish and cream-like; that of cattle and birds is often caseous; that of swine tenacious and green.

When pus remains for a long time in a vessel one observes two layers. The upper is a thin, apparently clear, and yellowish fluid; it forms the so-called pus-serum. The under layer is thick and straw-yellow; it contains the pus-corpuscles. The pus-corpuscles are formed principally from the white blood-corpuscles that migrate from the blood vessels (Cohnheim). Part of them, however, are descendants of the fixed connective-tissue cells, as well as the degenerated connective-tissue substance of the tissue. Upon microscopic examination one finds, in addition to the pus corpuscles, various forms of pus cocci which are occasionally enclosed within the pus corpuscles. There are also observed various other bacteria, red blood-corpuscles, tissue cells, drops of fat, crystals of fatty acids and cholesterin. The recognition of cartilage cells and giant cells in the pus are of special importance in the diagnosis of cartilage and bone fistulæ. The peptone contents of the pus is due to the transformation of the fibrinogen through the activity of the pus forming microorganisms; absence of fibrinogen in the pus accounts for its non-coagulability.

When the suppuration does not remain confined to the wound, but involves the neighboring tissues in a suppurative inflammation, it leads to the development of a diffuse suppurative inflammation of the subcutaneous and submucous cellular tissue (suppurative phlegmon), a circumscribed accumulation of pus (abscess), a suppurative inflammation of the lymph vessels (lymphangitis), lymph glands (lymphadenitis), and veins (phlebitis), as well as the entrance of pus cocci and their toxins into the blood (wound fever, septicaemia, pyaemia). Compare with the subsequent chapter.

2. The Phlegmons.

Definition.—Phlegmon, phlegmonous inflammation, or inflammation of connective tissue are terms used to indicate an infectious, serous, or suppurative inflammation of the connective tissue and all its parts; namely, the subcutaneous, submucous, subfascial, intermuscular, peri-

osteal, perichondral, tendo-vaginal, and interglandular connective-tissue. One speaks, then, of a subfascial or intermuscular phlegmon, of a phlegmon of the subcutis, the perichondrium, the tendon-sheaths, the udder, etc.

CAUSES AND FORMS.—Phlegmonous inflammation is due to the same bacteria that are found in suppuration. The streptococcus pyogenes and staphylococcus pyogenes aureus are the most frequent causes of phlegmons (phlegmone streptococcia or streptomycosis; phlegmone staphylococcia or staphylomycosis). The pus cocci usually gain entrance to the connective tissue through wounds; punctured, contused, and lacerated wounds form the ordinary sources of phlegmons. Very often the previous wounds are very small or entirely healed so that they can no longer serve as a source of entrance to pus forming bacteria. Formerly, the erroneous term of so-called spontaneous phlegmon was given to this condition. Phlegmon may occur at a point more or less removed from the point where the pus cocci gain entrance; they being carried to this point through the lymphatic circulation. It may also occur that the infection of the connective tissue proceeds, not from without, but from the blood stream (metastatic or symptomatic phlegmon of pyaemia, strangles, contagious pleuro pneumonia, glanders). Hemorrhage and lacerations of connective tissue as a result of contusions predispose to phlegmons.

Surgically there are various forms of phlegmon. Classified from an anatomical standpoint we have—subcutaneous, submucous, subfascial, intermuscular. It is also spoken of as superficial and deep (e. g. subfascial), or circumscribed and diffuse phlegmon. The circumscribed form confines itself to a phlegmonous swelling in the vicinity of the wound and frequently leads to the formation of an abscess (phlegmonous abscess). Diffuse phlegmon consists of an inflammatory infiltration of large areas of connective tissue and frequently results in necrosis of the skin, subcutem, fascia, tendons, tendon sheaths (gangrenous phlegmons), whereby other bacteria may also play a part (necrosis bacillus).

Septic phlegmon, in contrast to the ordinary form, is especially virulent. It is also termed progressive phlegmon, progressive inflammation of the cellular tissue, or gangrenous erysipelas. It is due to a mixed infection of pus cocci and specific septic bacteria (streptococcus septicus, micrococcus tetragenes, colon bacillus, and others). It is characterized by a rapid, extensive, ichoric suppuration of the cellular tissue, with a severe, often fatal general infection. The so-called gas phlegmon is a mixed infection composed of gas-forming bacteria (bacillus phlegmonæ emphysematosæ, colon bacillus). The ordinary suppurative phlegmon is termed simple in contrast to the specific phlegmons. The latter are not due to pus cocci, but to certain other bacteria, especially the bacilli which cause malignant edema and erysipelas (compare with the chapter on these subjects).

General Symptoms of Phlegmon.—Circumscribed phlegmon is characterized by swelling, high temperature, and pain over a small area of the skin. At first the swelling has a well defined boundary ; on palpation it may be hard and firm, or soft and fluctuating. As a result of the swelling and tension the skin cannot be raised. Circumscribed phlegmonous swellings frequently result in the formation of an abscess ; it is characterized by fluctuation, a reddish-blue or dark grey color of the skin, and fever. Spontaneous evacuation may occur after necrosis of a small portion of the overlying skin. Healing follows by the formation of granulation tissue, when not evacuated artificially it may result in burrowing of pus as well as in progressive phlegmon. Suppurative lymphangitis, lymphadenitis, phlebitis, as well as pyaemia and septicaemia may also occur.

Diffuse phlegmon is characterized by extensive swelling of the skin—especially on the limbs—fever, and pain (lameness). Subfascial phlegmon is accompanied by especially high fever and severe pain, when the deeper layers are affected the skin may remain unchanged, or presents a slight, edematous, doughy swelling. Intermuscular phlegmon is similar in appearance. All diffuse phlegmons frequently lead to extensive necrosis of the skin, subcutem,

fascia, muscle, etc. They often result in fatal septicaemia or pyaemia.

Septic phlegmon is very acute, spreads rapidly, and usually terminates in death. It is characterized by a high septic fever, extensive gangrenous destruction of the subcutem and neighboring soft parts, namely, the muscles, which are transformed into a discolored, odorous, punk-like, fatty mass, or a thin, ichoric discharge. The diseased parts may crepitate as a result of the formation of foul gases (gas phlegmon, septic emphysema).

TERMINATION.—The course of phlegmons varies according to their character and extent, as well as with the genus of the animal.

1. Circumscribed and diffuse phlegmons are followed by healing through resorption. The latter, especially, frequently heal without necrosis or abscess formation.

2. Abscess formation may result from any kind of phlegmon. The prognosis is more favourable when the phlegmonous inflammation is situated near the surface. Subfascial and intermuscular abscesses are a source of danger, they may be in the form of numerous, small pus foci, or converge to form a large abscess, general infection is liable to occur. Occasionally subfascial abscesses rupture spontaneously on the surface.

3. Necrosis may result from any form of phlegmon. It most often results from septic, subfascial, intermuscular, periosteal, and perichondral phlegmons, especially when there occurs a simultaneous influence of the necrosis bacillus (fistulous withers, poll evil, quittor, phlegmon of the planter cushion). Necrosis often forms the source of septicaemia and pyaemia.

4. Encapsulation of abscesses is most often observed in intermuscular phlegmon (shoulder abscess). In diffuse, subcutaneous phlegmons on the posterior limbs of the horse the phlegmonous process is occasionally suspended for a long time, healing is only apparent ; sooner or later the phlegmon returns. Possibly this recurrence explains a previous encapsulation-isolation of individual disease foci, with a sub-

sequent spreading of the inflammatory process as a result of rupture, laceration, or liquefaction of the capsule.

5. Chronic induration or schlerosis occurs when a diffuse, suppurative phlegmon terminates in a chronic connective-tissue proliferation of subcutaneous, intermuscular, subfascial, and perichondral tissue. Schlerosis occurs on the posterior limbs after phlegmons (elephant leg), grease, or on the head (glanders), and leads to pronounced thickening of the skin; it is termed elephantiasis, pachyderma, or schleroderma. Compare with the chapter on elephantiasis.

TREATMENT.—When there is no evidence of abscess formation and resorption is possible, treatment consists in the application of moist, hot fomentations (Prieznitz), or disinfecting bandages (spirits of camphor bandage); antiseptic lotions, warm baths or cataplasms; ointments of camphor, iodoform, tar, carbolic acid, creolin, grey mercury; as well as subcutaneous injections of disinfectants. In subacute, and in chronic phlegmons especially, resolution or accumulation of the pus in a circumscribed cavity may be attained by the application of a severe counter-irritant in the form of tincture of iodine or unguentum hydrargyri cinereum. Arecolin is a very good internal resorbent.

All abscesses, on the other hand, should be treated early by means of a free incision. Experimental investigations as well as practical experience have demonstrated that early evacuation of the pus by means of open incisions is the most satisfactory treatment (disinfectant activity of the oxygen of the air). One may also irrigate the abscess cavity with antiseptic fluids and provide drainage. All necrotic tissue must be removed (amputation of the tail and claws; resection of the lateral cartilage and the flexor tendon at its point of attachment to the os pedis). The application of massage is contra-indicated, especially for acute phlegmons.

OCCURRENCE. — Most phlegmons are subcutaneous.

Phlegmonous inflammations of the subfascial, intermuscular, and perichondral connective tissues, as well as the tendon sheaths are common, especially in the horse. Septic phlegmons are very common in horses and dogs. The following phlegmons are of special practical importance:

1. Subcutaneous phlegmon of the soft parts of the head (lips, eyelids, zygomatic region, pharynx); throat, and shoulder (subcutaneous injections);

2. Submucous phlegmon of the mucous membranes of the mouth and throat (stomatitis, glossitis, pharyngitis);

3. Subfascial phlegmon of the fasciae of the throat, shoulder, and back (poll-evil, fistulous withers);

4. Phlegmon of the muscles of the throat shoulder, elbows, gluteal region, and abdomen in the horse (deep wounds);

5. Subcutaneous phlegmons of the posterior limbs of the horse in both forms: the ordinary simple and the rare, characterized by abscess formation;

6. Subcoronary and perichondral phlegmons at the coronet (treads on the coronet), and the lateral cartilages (fistulae of the lateral cartilages), as well as phlegmon of the planter cushion in the horse (nail punctures);

7. So-called panaritium of the claws of cattle and dogs, corresponding to the subcoronary phlegmon of horses (see below);

8. Subfascial phlegmon of the fascia lata and the tibial fascia in the horse (punctured injuries, wounds from blows);

9. Phlegmon of the tendon-sheaths of the flexor tendons in the horse (traumatic, suppurative, and metastatic);

10. Subcutaneous and intermuscular phlegmon of the tail in cattle (lung plague injections, so-called tail worm), dogs (contusion), and horses (amputation);

11. Phlegmon of the sheath and scrotum in the horse (wounds, castration, glanders);

12. Phlegmon of the udder in cattle (small wounds, erysipelas, and furunculosis);

13. Puerpural phlegmon in cattle (septic gas-phlegmon, so-called puerpural blackleg) from small contused wounds of the vulva and vagina at birth.

PANARITIUM.—This name (derived from paronchium—inflammation of the bed of the nail—matrix unguis—) indicates a circumscribed phlegmon of the phalanges. In man, it applies to a special circumscribed, suppurative inflammation of the subcutaneous connective tissue on the volar surface of the finger. The word is derived from human medicine, and in veterinary science the application is somewhat false. In man the anatomical structure of the subcutis predisposes to the existence of panaritium. The subcutaneous tissue on the volar surface of the finger is very thick, and its connective-tissue fibers are not parallel with the finger, but run perpendicular to it. Upon the entrance of pus cocci there first occurs a circumscribed inflammatory focus surrounded by fixed connective-tissue fibers (panaritium). The phlegmonous process extends from here to the tendon-sheaths, the periosteum, the joint, and the bone, there exists a progressive phlegmon (panaritium tendonosum, periostale, articulare, osseum) which may lead to necrosis of the bones, suppurative inflammation of the joints and tendon-sheaths, to necrosis of the tendons, and death of the entire phalanges, even to fatal septicemia and pyemia. Very similar processes occur on the hoof of the horse, the claws of cattle, sheep, and dogs. All the above forms of panaritium can be observed in the sheep and dog especially. In cattle one can distinguish panaritium of the toes, panaritium between the claws and between the balls. The term phlegmon is more often employed. Subcoronary phlegmon of the horse is analagous to panaritium when it is complicated with phlegmon of the planter cushion, of the perichondrium, of the bursa of the navicular bone, as well as with necrosis of the flexor perforans, with fistula of the cartilage of the hoof, and suppurative inflammation of the pedal joint.

3. ABSCESS.

DEFINITION AND CAUSES.—Abscess (abscessus, apostema) is an accumulation of pus which is usually the product of a suppurative inflammation; it may develop from suppurative phlegmons, suppurative wounds, purulent hematomata, or metastatically through the blood. Pus bacteria, are the most frequent causes of abscess formation (staphylococcus and streptococcus pyogenes). Abscesses in horses are very often due to the streptococcus of strangles and the botryomyces fungus. In other cases the abscesses contain diverse bacteria; occasionally the mi-

crococcus tenius, the bacillus pyogenes fetidis, the colon bacillus, and other bacteria are the causes of abscesses. Occasionally abscess formation is due to a mixed infection with various microorganisms (tubercular and actinomycotic abscesses). In addition to pyogenic bacteria gas-forming organisms may gain entrance, for example, bacillus phlegmonae emphysematosae, thus the so-called gas abscesses exist.

PUS BACTERIA IN DIFFERENT DOMESTIC ANIMALS.—In HORSES staphylococci and streptococci, as well as botryomyces, are the most frequent causes of suppuration. According to Hell there are no positive differential characteristics between the coccus of contagious pleuropneumonia and pus cocci; the former may result in pus formation. Foth found streptococci of strangles and staphylococcus aureus in a strangles-abscess in the horse; he is of the opinion, that under certain conditions, suppuration occurs in horses not affected with strangles, as a result of the activity of a streptococcus that cannot be differentiated from that of strangles by means of our present bacteriological methods. Schuemacher and Willach found a diplococcus in pus taken from a wound on a horse; they were unable to discover any differential characteristics between this and the cause of contagious pleuro pneumonia. They thought that many suppurative processes were related, therefore, to contagious pleuro pneumonia. For shoulder abscess in the horse Bossi named a special pus-organism (micrococcus myositidis equi aureus and albus). According to Baldoni the cocci of shoulder abscess in the horse are identical with the pus cocci of man, except that they are more virulent. According to Jensen botryomyces fungi are the principal organisms in shoulder abscess. Schmidt found strangles cocci in a shoulder abscess. I, myself, found botryomyces fungi in 25–50% of shoulder abscesses; ordinary pus cocci in 50–75%; occasionally streptococci of strangles were found. Lucet and Nocard maintain that abscesses in CATTLE are caused by special pus-organisms that have not yet been described, that they have demonstrated them bacteriologically and given them special names as follows: streptococcus, staphylococcus, and bacillus pyogenes bovis; bacillus liquefaciens pyogenes bovis, and bacillus crasus pyogenes bovis. The bacillus pyogenes bovis is identical with bacillus pyelonephritidis. In SWINE, according to Grips, the bacillus pyogenes suis is a specific pus-forming bacterium that can be demonstrated in nearly all abscesses. Künneman found a special bacillus in 90% of all processes in cattle, which he named bacillus pyogenes bovis; this is not identical with Lucet's bacillus. Pure cultures of this organism produce subcutaneous abscesses in cattle, in the vagina they cause a suppurative vaginitis. According to Glage the bacillus pyogenes suis and bovis are identical; it forms the most frequent pus-organism in swine and cattle, and is apparently transmitted

to swine through the milk of cattle suffering from disease of the udder. Jensen found the colon bacillus in prostatic abscesses in the DOG, he also found the same organism in suppurative peritonitis, cystitis, and pyelonephritis in the same animal.

FORMS OF ABSCESS.—The following forms of abscesses are recognized: hot or cold (caused by acute or chronic suppurative inflammation). Cold abscesses are usually of tubercular, actinomycotic, and botryomycotic origin. Other classifications are: superficial and deep, primary and secondary, symptomatic or metastatic (strangles, pyaemia, tuberculosis, glanders), simple and multiple, congestive or wandering (wandering abscesses either pass downward from their own weight, or upward in the hoof, passing in the direction of least resistance), subcutaneous, subfascial, intermuscular, strangles, bone, or hoof abscess. One also speaks of a fecal or urinous abscess.

OCCURRENCE.—Abscesses occur in all domestic animals, especially in horses, dogs, and cattle. Avian abscesses have a peculiar, dry, caseous appearance. Abscesses are usually found in the subcutis, lymph glands, beneath fascia, in muscles, and in the mammae; bone-abscesses are rare. In the horse they are most often found in the following parts: pharynx (abscess of the lymph glands), at the coronet (coronary abscess), throat (subcutaneous injection), shoulder (shoulder abscess), saddle positions, gluteal region, the leg, the anterior surface of the carpus, and the inner surface of the metacarpus. In the dog their favorite seat is on the head and throat (bites). Abscesses in old cattle usually develop slowly (cold abscesses).

SYMPTOMS.—A subacute abscess has the appearance of a circumscribed, hot, painful swelling. It is fluctuating at the center and firm at the periphery. The skin is adherent over its surface. In the absence of pigment one observes a reddish-blue or grayish discoloration of the skin, it also has a glistening appearance. Fever often exists at the same time. Deep, or subfascial abscesses are characterized by a diffuse swelling without fluctuation.

In differential diagnosis one must distinguish between hematomata, phlegmons, galls, and new formations. An abscess is diagnosed as follows: it develops gradually under inflammatory conditions, it fluctuates, the skin is moveable on the surface, discoloration in white-skinned horses. Fever may also exist. To diagnose a deep or subfascial abscess it may be necessary to use an exploring needle. Sometimes deep abscesses are characterized by a high, septic, continuous fever, and by an intense, diffuse, very painful swelling.

TREATMENT.—The treatment of abscesses is purely surgical. It consists in early and complete incision with subsequent antiseptic irrigation. The formerly used "expective" treatment—waiting for spontaneous discharge of pus—is no longer considered good surgery. The skin becomes necrotic, the process is prolonged, suppuration is more extensive, especially in subfascial abscesses, when the life of the patient is in danger. Very large abscesses, especially subfascial, should be drained. Caution is required when opening deep abscesses in the vicinity of the larynx; only the skin should be incised with a knife, then bore with the fingers or some blunt instrument (sound, blunt pointed scissors) to the depth of the abscess. The opened abscess should not be tamponed, but treated as an open wound and drained. Cold abscesses may be treated with extirpation of their capsule (shoulder abscess), sutured, and then drained. Subfascial abscesses with pronounced extention, and necrosis of the neighboring fascia and muscle (fascia of the withers in the horse as a result of fistulous withers) are occasionally incurable (septicaemia).

4. WOUND FEVER.

NATURE AND CAUSES.—The term fever indicates a role of symptoms that are complex in character; they are the result of various derangements of the general system. The most important are: elevation of temperature, increased frequency of the pulse, derangement of the distribution of the

blood and blood pressure, as well as alteration in its composition. The digestive, respiratory, and nervous system are also deranged. Elevation of temperature is not the only symptom of fever.

The exact changes that take place during the existence of a fever are not yet fully understood. The most important changes, on the one side, seem to be increased assimilation, especially of albumen, as a result of changes in the blood; on the other side, the heat center of the brain appears to play a part. This center regulates the distribution of the heat as well as the development of the heat in the body (caloric center). When the heat center is irritated, elevation of the temperature occurs; when it is weakened or paralyzed, the body temperature becomes subnormal. Irritation of the heat center with a subsequent rise of temperature may be produced in various ways. Traumatic injuries from some instrument or as a result of other injuries (burns), or thermic through a high degree of heat (heatstroke, sunstroke), numberless chemical agents (toxins, ferments, mallein, tuberculin), reflex action as a result of pain (so-called nervous fever). Conversely, the heat center may become weakened or paralyzed with a subsequent fall of temperature. The factors which cause this condition may be traumatic (destruction of the heat center), thermic (cold), chemical (antifebrin, antipyrin).

In wound fever increased assimilation is combined with alterations in the blood, derangement of the heat regulators, and irritation of the heat centers. Apparently this is due to the resorption of dissolved bacterial toxins, as well as certain chemical agents found in the wound secretions. Wound fever may be termed a resorption fever. If the resorbed material is of bactericidal origin—bacteria or their toxins—it is termed a septic or bacterial fever (infection-fever, intoxication-fever, septicemia, pyemia). In a great many cases fever accompanies mild wounds, for example, after castration, or non-infected wounds, subcutaneous bone fractures, blood extravasations. The fever is apparently caused by the resorption

of ferment-like products produced by degeneration of the blood and tissues. Their action on the blood and nervous system is similar to that of the toxins of bacteria. Fever thus produced is called aseptic or ferment fever. The chemical agents thus generated are ferments of the blood and tissues (fibrin-ferment, histozyme), organic material from the degeneration of cellular tissue (nuclein from the nuclei of white blood corpuscles, free hemaglobin), and occasionally glandular secretions. One observes aseptic fever after the transfusion of blood, as well as in horses that have been restrained.

SYMPTOMS—Elevation of temperature in wound fever varies according to its intensity and course. In the dog and horse it is classified as mild (39.5° C); medium (40.5° C); high (41.5° C). Wound fever is sometimes continuous (septicemia), sometimes remittent, usually however, atypical. It is seldom intermittent (pyemia). Aseptic wound fever is not characterized by pronounced general symptoms, for example, that following castration in the horse. In septic wound fever, on the other hand, one observes: elevation of temperature, derangement of the appetite, digestion, and activity of the heart; emaciation; psychic derangements, etc. Septic wound fever is often followed by septicemia and pyemia. (See chapter that treats these subjects).

TREATMENT.—The main therapeutic problem consists in the local treatment of the wound. In aseptic wound fever it is usually sufficient to change the bandage, thoroughly remove the pus, and disinfect the wound. The drainage of wounds and incision of abscesses produces the same result.

Septic wound fever, in addition to the above, should be treated internally with febrifuges. The most active surgical antipyretics (especially with synchronous weakness of the heart) are camphor and alcohol, they are best administered in the form of subcutaneous injections of spirits of camphor.

5. Septicemia.

Definition and Causes.—Septicemia (sepsis, blood poisoning, putrid fever) is a severe wound infection disease characterized by the presence of bacteria and their products of degeneration in the blood. Unlike pyemia, it is not accompanied by internal or external local affections (metastasis), but by general changes in the structure of the internal organs. This is especially characterized by swelling of the spleen, and parenchymatous inflammation of the liver, the kidneys, the heart, and the other internal organs. It often occurs that septicemia and pyemia are combined (septico-pyemia, pyo-septicemia).

From an etiological standpoint two principal forms of septicemia are recognized: one due to the action of bacteria, the other to that of chemical poisons (toxins). That due to bacteria is termed bacterial septicemia, bacteriemia, or septic infection; that which results from toxins is termed septic intoxication. The former may be transmitted through the blood to other animals, while the blood of the latter is not infectious. Between the two there are transitional forms and combinations (mixed infection). If no cause can be found for the existence of septicemia, it is termed cryptogenic septicemia.

1. Septic infection is caused by several bacteria, they may be cocci or bacilli. One can differentiate, therefore, between a coccidial and a bacterial septicemia. Some of the cocci which may produce septicemia are the streptococcus septicus and the micrococcus tetragenes; the cocci which produce pyemia, namely, streptococcus pyogenes and staphylococcus aureus are also able to cause septicemia. The experimental investigations of Koch have demonstrated the pathogenic action of the following bacilli: the so-called bacillus of mouse septicemia, as well as the bacillus of rabbit speticemia, the group futher includes the colon bacillus and the bacillus enteritidis. Specific

speticemias, in contrast to the simple forms, may be caused by malignant edema, anthrax, blackleg, the organism of erysipelas, and hog cholera, the septic form of so-called foal lameness, calf septicemia, septicemia hemorrhagica (wild-seuche), chicken cholera, and chicken plague.

2. Septic intoxication is due to the entrance of the poisonous products of bactericidal metabolism. These products are termed toxins, ptomaines, putrid virus, cadaver or septic poisons, and meat poisons, their chemical structure is extremely variable (toxalbumen; albumoses, organic bases namely, amine and nuclein bases, fatty acids, and aromatic products). Usually these toxins are absorbed from a purulent focus on the surface of the body, or they may be absorbed from the uterus, intestines, lungs, or liver. As a rule it is the above named pathogenic bacteria that colonize in ichoric wounds, in retained decomposing secundines (puerpural septicemia), or in ichoric foci in the intestines and lungs, and whose products of metabolsim are resorbed. Other organisms, especially the bacteria of putrefaction, can gain entrance to wounds and pus foci in the body. They result in putrid decomposition of animal tissues, from which are formed strong chemical poisons, which are resorbed and cause general intoxication. That form of septicemia due to the products of metabolism of putrefactive bacteria (saprophytes) is termed sapremia. Proteus vulgaris and the closely allied bacillus cellulæformans (flesh poisoning) are especially dangerious in this connection. Migration of the saprophytes, themselves, to the blood, was formerly supposed to be a cause of septicemia; according to recent investigations this appears to occasionally take place.

PATHOLOGY.—On post mortem examination of animals that have died from septicemia, the following conditions are noted: The blood is of a tar-like consistence and has the appearance of varnish. The blood as well as the solid organs of the body manifest a tendency to putrefy. In septic infection a microscopic examination of the blood reveals the concerned bacteria, which have led to a decomposition of the white and red blood-corpuscles. The

white blood-corpuscles, in particular, are transformed to formless colonies of bacteria as a result of the numberless organisms that have gained entrance. As a result of parenchymatous disease of the vascular walls, there occurs a hemorrhage into the mucous membrane, beneath the serous membranes—especially beneath the endocardium—into the mesometrium and omentum, kidneys, spleen, and liver.

The spleen, liver and kidneys usually show parenchymatous swelling, the heart-muscle, and occasionally the skeletal muscles, have a cooked appearance. In many cases there also exists an ulcerative endocarditis; a catarrhal, hemorrhagic, and even diphtheretic enteritis; as well as a parenchymatous and hemorrhagic nephritis. In very acute cases of septicemia these changes are not pronounced. This is especially true of the toxic form, where, similar to poisoning, post mortem may give negative results. (Caution in the inspection of meat!).

SYMPTOMS.—Septicemia is the most important and the most frequent general wound infection disease. It is found in the horse after traumatic, pyo-ichoric inflammations of the joints (pedal joint, tarsal joint) and the tendon-sheaths, as well as in severe septic, subfascial and intermuscular phlegmons. In the cow and bitch septicemia frequently follows parturition (puerperal septicemia). Comparatively speaking, swine are very resistant to septicemia (castration). According to the seat of origin, the local changes are extremely variable.

1. Septicemia in the horse is characterized by a septic phlegmon around the margin of the wound. Sometimes local wound changes are absent (peracute cases). The general symptoms usually begin with severe febrile indications. The temperature may go to 42 C., and over, occasionally it is accompanied by chills, the pulse is frequent, small, and finally imperceptible, heart weakness is pronounced. In many forms of septicemia, elevation of temperature may fail. One occasionally observes severe general symptoms: complete loss of appetite (occasionally horses eat a quarter or half ration to within a short time of their death),

pronounced emaciation and weakness, heaviness of the sensorium, trembling, sometimes paralysis of the posterior limbs, profuse and continued perspiration, dirty-red or icteric coloration, and echymosis of the mucous membranes, discolored, albumenous urine, and towards the end, profuse diarrhea with symptoms of colic. The duration of the disease is extremely variable; it may terminate fatally within twenty-four hours, it usually continues, however, several days, and may exist for several weeks (inflammation of the pedal joint).

2. In cattle puerperal septicemia is the most frequent form (septic form of puerpural fever). Clinically, both forms of septicemia may be recognized; infection and intoxication. Puerperal infection is characterized, either by a puerperal phlegmon, a septic metritis (fever, straining, groaning, pain on pressure over the abdomen, stinking, chocolate colored discharge from the uterus, diphtheretic changes on post mortem); or by an acute puerperal septicemia, which is differentiated from the preceding by general septic conditions (sudden loss of appetite and lacteal secretions, high fever, yellow mucous membranes, and weakness). As a rule it leads to death in from one to three days, and the post mortem changes are frequently slight or imperceptible. Puerperal intoxication exists, either in the form of a parturient paresis (paralytic calf fever, auto-intoxication), or slight symptoms of disease (weakness, gastric derangement, normal temperature). Retention of the after-birth, especially, is a cause of a mild form of sapremia; sudden paralytic conditions with death after a few hours are rare (De Bruin).

TREATMENT.—As in a wound-fever, so in septicemia, local antiseptic treatment of the wound is of greatest importance. Apply powerful disinfectants, carefully remove stagnated wound-secretions, give thorough drainage, incise early all fluctuating spots. A puerperal uterus should be thoroughly irrigated and any retained placentae removed. The internal administration of febrifuges is of secondary importance. Those agents which have been of greatest service

are: camphor, alcohol, and quinine. Argentum colloidale as well as quicksilver in the form of small doses of calomel are employed internally. Antistreptococcic serum, on the other hand, has not proved satisfactory.

6. Pyemia.

Definition and Causes.—Pyemia is a general wound-infection disease; in contrast to septicemia it is characterized by the formation of suppurative foci of disease in the body (metastases). The bacteria of pyemia are essentially those of septicemia. The most frequent causes of pyemia are pus-cocci, especially, staphylococcus pyogenes aureus, and streptococcus pyogenes. These are found in any abscess, and are the ones usually involved in metastasis (staphylomycosis multiplex, staphylohemia, pyemia metastatica). They enter the blood from a primary pus-focus, colonize in the various internal organs, where they multiply and cause suppuration. An acute or chronic pyemia depends on whether the pus cocci enter the blood stream suddenly, and in large numbers; or gradually, and in small numbers. In general, pyemia is much less common than septicemia. In the horse it is usually the result of a septic, degenerating thrombophlebitis arising from wounds of the hoof, umbilicus, of the jugular vein, following injuries of the bone as well as from resorption of internal pus-foci (strangles). Pyemia of foals and calves which develops from a suppurative thrombophlebitis of the umbilical cord (pyemic form of the so-called foal lameness or calf lameness) is of practical importance; these diseases possess no bacteriological individualities, in foal lameness, especially, staphylococci as well as streptococci have been demonstrated as a cause of the disease; in calf lameness the colon bacillus has been recognized. In cattle, pyemia usually develops from the internal organs, especially from the uterus (pyemic form of puerperperal fever), when it originates from a suppurative thrombo-phlebitis of the uterine veins, it seldom results from traumatic gastritis. Strangles in the horse is a specific type of pyemia; the same is true

of so-called dog distemper (suppurative folliculitis of the lips with secondary lymphangitis, lymphadenitis, and metastatic formations). Occasionally the origin of pyemia cannot be determined (cryptogenic pyemia).

In many cases it is impossible to distinguish between septicemia and pyemia, they both exist at the same time; one then speaks of a pyo-cepticemia. From a standpoint of practical surgery it is essential, however, to differentiate between cases of pure pyemia and septicemia.

PATHOLOGY.—The anatomical characteristics of pyemia are a greater or lesser number of suppurative inflammatory foci (metastatic processes) in the internal and external organs (lungs, liver, spleen, kidneys, brain, heart, skeletal muscle, joints, tendon-sheaths, etc.). In foal lameness, suppurative inflammation of the synovial tissues of the joints is the main characteristic (polyarthritis pyemica). One also observes, suppurative inflammation of other serous membranes, the peritoneum, the pleura, the meninges; as well as suppurative inflammation of the eye (suppurative choroiditis and panophthalmia). Occasionally, one also observes, as in septicemia, an ulcerative endocarditis and numerous circumscribed hemorrhages on the serous membranes, in the skin, in the eyes, and in the muscles. Anatomical changes characteristic of septicemia may also be present (septico-pyemia). Finally, the local changes are sometimes very characteristic; for example, as a result of the colonization of numerous bacteria in the venous walls of the wound (umbilical wound), there occurs a suppurative inflammation of the vascular walls with suppurative degeneration of the organized thrombus (suppurative thrombo-phlebitis). This forms a source of the suppurative embolic foci within the body, as well as a point of origin for many bacteria that are present in the blood and inner organs (micrococci).

SYMPTOMS.—Pyemic wound infection is ushered in with a varying, frequently intermittent, very irregular fever, and occasionally with chills. After this there develop symptoms of metastatic inflammation of the lungs, or symptoms of abscess formation in

the liver, kidneys, or brain, pyemic polyarthritis, tendovaginitis, pleuritis, meningitis, etc. Occasionally, one further observes multiple, subcutaneous pus-foci, which often develop suddenly in large numbers in the form of phlegmonous swellings in various parts of the body. Pyemia usually runs a longer course than septicemia; usually from a few days to a few weeks, depending on the seat and course of the metastasis. It may develop into a chronic pyemia with pronounced emaciation of the animal. Recovery is more frequent than in septicemia, although it is uncommon, and convalesence occurs only after a long time.

Puerperal pyemia (pyemic form of puerperal fever) is characterized by a febrile polyarthritis on the carpal and tarsal joints, mastitis, osteomyelitis, and tendovaginitis of the flexor tendons, as well as chronic parametritis (multiple abscess in the pelvic connnective tissue, chronic emaciation). It occurs in cattle, but is rare in horses.

Strangles-pyemia (so-called wandering strangles) develops principally in the form of abscesses of the lymph glands in various parts of the body (superior, middle, inferior cervical glands, axillary glands, bronchial glands, omental glands, pubic glands, lumbar glands, popliteal glands) as well as abscess formation in the brain, spinal marrow, omentum, udder, kidneys, pancreas, orbit, etc.

TREATMENT.—As in septicemia, the principal treatment consists in careful local disinfection, drainage, and incision. On account of its specific action as a febrifuge, quinine may be tried.

7. THE REMAINING WOUND INFECTION DISEASES

ERYSIPELAS.—In man, this disease is a specific, infectious inflammation of the skin and subcutem; it involves the rete Malpighi and the papillary bodies. Through the medium of the lymph stream it rapidly spreads over large areas of the skin, and leads to severe general infection; the local changes, however, are usually slight. A superficial wound is usually the point of origin of the infection. The bacteriological investigations with

reference to the bacteria which cause erysipelas are very contradictory. It was formerly thought to be entirely due to the streptococcus erysipelatis, a specific organism discovered by Fehleisen. According to recent investigations (Baumgarten, Fraenkel, and others), the specific action of the coccus of erysipelas, on the other hand, is very doubtful; this organism appears to be identical with streptococcus pyogenes. The theory has been advanced, therefore, that erysipelas is not a specific wound infection disease, but a localized form of septicemia in the skin. According to its virulence, each streptococcus may cause suppuration, erysipelas, phlegmon, abscess formation, pyemia, and septicemia (Marmorek). It is also claimed that erysipelas may be caused by staphylococci and typhus-bacilli. In man, therefore, according to the etiology, two forms of erysipelas are recognized: the primary, genuine type, due to streptococci; and the secondary type, which occurs during the course of various infectious diseases.

The symptoms of erysipelas in man consist in the appearance of a diffuse red swelling in the vicinity of the wound; the swelling spreads very rapidly, and frequently along the course of the lymph streams (migrant erysipelas, ambulant erysipelas.) In other cases new inflammatory foci arise in several distant places, they are manifestly metastatic (erysipelas multiplex). Corresponding to the extension of the erysipelas, there is observed a rapidly developing, high grade fever. As the result of an active serous exudation, blisters are formed in many places on the surface of the skin (erysipelas bullosum). As a rule, the erysipelas heals with rapid sinking of the fever and desquamation of the skin. In typical cases the healing is as rapid as the development (simple, typical, non-complicated erysipelas). In other cases phlegmonous and gangrenous processes are present (erysipelas phlegmonosum and gangrenosum). Other complications are: erysipelatous pneumonia, pleuritis, endocarditis, pericarditis, myocarditis, diphtheria of the pharyngeal mucous membranes, enteritis, intestinal ulcers, nephritis, inflammation of the brain, neuritis, peripheral paralysis of the nerves, suppurative panophthalmia, otitis, parotitis, as well as septicaemia, and pyaemia. In individual cases it has been observed that new formations (carcinoma, sarcoma, lymphoma, lupus) disappear after an accidental infection with erysipelas. Based on this experience, the unsafe experiment has been made of artificially producing erysipelas on the new formations mentioned by means of injections of erysipelatous cocci; the object being, to cause healing (erysipelas inoculation, curative, artificial erysipelas). Treatment of erysipelas consists in epidermatic and endermatic (parenchymatous) applications of disinfectants (carbolic acid, creosote, creolin, lysol, tar, ichthyol, tincture of iodine, sublimate), incisions of the skin, with antiseptic irrigation, application of pressure to the healthy margins (collodion, strips of sticking-plaster),

as well as cold. Recently the antistreptococcic serum has been applied. The fever is treated with camphor.

Concerning the OCCURRENCE OF ERYSIPELAS IN ANIMALS definite knowledge is scarce. This is partly due to the fact, that the most characteristic symptom, the redness of the skin, is wanting in animals on account of the pigment formation and hair. On the other hand, genuine, typical erysipelas appears to be much less common in domestic animals than in man. For this and other reasons, it is better not to use the word erysipelas in veterinary surgery, but in general, to speak of inflammatory edema. In CATTLE, "erysipelas of the udder," an erysipelatous, infections inflammation of the skin, is seen in the udder before and after parturition. The skin, on the posterior quarters of the udder in particular, and occasionally on the inner surface of the tibia, is very red, painful, and swollen. It is alleged that this affection is frequently complicated with phlegmons of the subcutem, and either leads to desquamation and healing, or permanent schlerosis of the skin. A fatal termination is never observed. In the HORSE, phlegmon of the posterior limbs is considered erysipelas by many; Kitt, for example, defines it as a dermatitis erysipelatosa, while Schindelka classifies it with the phlegmons. It is very questionable if the so-called erysipelatous form of scratches is genuine erysipelas. Malzew (Zur Aetiologie der Mauke. Inaugeral-Disseration. Dorpat, 1899) sustains the theory, that with few exceptions, those inflammations of the fetlock region, known as scratches, are genuine erysipelas. In scratches of the horse he claimed to have found regular streptococci, which were identical with those of erysipelas. Also, according to his experiments, erysipelas could be successfully transmitted from man and dog to the skin on the fetlock region of the horse. Considered from the standpoint; that specific erysipelatous cocci do not exist (see above); that these cocci are found much more often in non-erysipelatous, simple, suppurative inflammations of the skin; that the disease is neither general, nor has a tendency to spread; the erysipelatous nature of scratches is not a well supported fact. On the other hand, perhaps the case described by Semmer (Oesterreichische Monatshefte. 1895, S289) was one of genuine erysipelas. Three horses showed swelling of the lips after transportation in severe cold; this spread rapidly to the region of the cheeks, the pharynx, the throat, and the anterior part of the thorax. All three horses died after a short time. Post mortem examinations revealed the following condition: an exudate in the swollen portions of the skin that was sero-fibrinous, partly fluid, and partly gelatinous in character; the pleura, pericardium, and peritoneum presented hemorrhagic inflammations; in the thoracic and abdominal cavities, as well as in the pericardial cavity, there was an abundance of dirty-red fluid; on the omentum, and under the pleura of the lungs, there was an abundant

extravasate of blood; the spleen was enlarged. A pure culture of staphylococci were secured from the serous exudate of the swollen skin. Experimental cutaneous and subcutaneous injections of these in horses resulted in large, erysipelatous swellings at the point of injection (shoulder), which spread downwards to the carpus; fever and loss of appetite were also noted. In DOGS, among 70,000 cases of disease, I have observed symptoms referable to erysipelas in only four cases; I have described one case in the Wochenschrift für Tierheilkunde (1894). Schindelka's (Hautkrankheiten. 1903) experiences are identical with mine; he has observed only three cases of erysipelas in the dog. Möller, also, (Lehrbuch der Chirurgie. 1893) has only occasionally observed typical erysipelas in the dog. In SWINE, on the other hand, erysipelas is much more common in the form of erysipelas of the head; it may also be transmitted by inoculation to other swine (Fehleisen). Nothing definite is known concerning genuine erysipelas in sheep, cats, and birds.

MALIGNANT EDEMA.—Malignant edema is a specific phlegmon: it may be termed a sero-hemorrhagic infiltration of cellular tissue with gas formation. Apparently, the cause of the disease may be due to several bacteria. The most important is the malignant edema bacillus (bacillus edematis maligni) discovered by Koch. The bacilli of malignant edema form spores; they are very motile; liquefy gelatine; take Gram's stain; they are anaerobic rods 3 to 5 micro-millimeters in length, and one mirco-millimeter broad; they are four times as long as broad and a trifle slimmer than the anthrax bacillus. Several rods become adherent to form threads 10-40 micro-millimeters in length. After the death of the animal the edema bacilli increase rapidly in length, and form threads which are partly straight, partly curved, and partly twisted; they are arranged in such a manner as to give one the impression of bacilli arranged upon one another in rows. Spores are afterwards formed from these threads. In cadavers of asphyxiated individuals that have been kept for 24 hours at a temperature of 38° C, large numbers of malignant edema bacilli are found in the blood, especially in that of the portal vein (migration from the intestines). By the same method, the so-called cadaver-bacilli are constant in the blood of the liver and in the spleen after 12-24 hours, in the general circulation of our domestic animal cadavers soon after, as the result of death due to dyspnea, especially from colics, when they remain unopened for some time in a warm place (confusion with anthrax bacillus!). There are also various forms of pseudo-edema bacilli (earth bacilli).

The edema bacillus is extremely abundant in nature. It is especially numerous in the upper layers of the earth. If a small

amount of ordinary garden soil is brought beneath the skin of a rabbit, the animal dies from malignant edema in from 24–36 hours. The spores of malignant edema are also found in horses that are entirely normal, in the saliva and in the feces, so that infection may readily occur in the oral cavity and in the vicinity of the anus. For this reason, infections are very common in the vagina and in the puerperal uterus. The infection results from an unclean condition of wounds of the skin or mucous membrane; and may be conveyed by means of soil, feces, saliva, dust, etc., it depends, however, on the entrance of the edema bacillu into the subcutaneous or submucous connective issue. The entrance of this organism into the circulating blood is comparatively harmless because the oxygen of the blood is fatal to anaerobic bacteria. Inoculation of the cutis also, produces no results (oxygen of the air). It is also difficult for the bacilli to enter granulating wounds. Moreover, the subcutaneous and submucous connective tissue must be previously weakened by means of previous contusions, the entrance of foreign bodies, ulceration, etc., before the edema bacilli gain entrance. This depends, first, on the existence of a nourishing media for the bacilli (serum, lymph, blood). Then the infectious material must be as free as possible from the oxygenated blood, as the oxygen of the blood is fatal to the bacilli. The greater the interruption of the circulation in the infected area, the more favorable are the conditions for the growth of the edema bacillus. According to recent investigation (Besson), genuine spores of the edema bacillus cannot develop in the healthy tissues of living animals (phagocytosis). Their development much more dependent on association with other bacteria (microbes favorisants) especially with staphylococci. This condition explains, as in tetanus, that, regardless of the frequency of the occurrence of the edema bacillus (ubiquity), cases of sickness from malignant edema are relatively uncommon in animals.

Since Kitt has demonstrated that malignant edema could be experimentally transmitted to domestic animals, numerous cases have been observed in cattle, horses, and sheep (Jenson and Sand, Reuter, Attinger, Elmenhoff, Nielson, Friis, Mesnard, Besson, Horne, de Bruin, Willach, Albrecht, Kitt, Gilruth, Reakes, personal observations). The causes are due to injuries, for example, subcutaneous injections of eserine, injuries of the tongue by means of food, foreign bodies, bites, and perforating wounds; injuries to the uterus, the vagina, and the vulva (so-called puerperal blackleg which may also be caused by the pseudo-edema bacillus and the genuine blackleg bacillus), operations with unclean instruments, castration of sheep and goats, amputation of the tail. In the Province of Brandenburg, in 1897, from 600 freshly shorn sheep, 50 died from malignant edema (Lembcken); in New Zealand, in 1900,

among 4,000 shorn sheep, 300 died from malignant edema. In one case in a horse, I observed a twelve-hour period of incubation. Obviously, malignant edema has been known for a long time in veterinary science, but under other names (flying necrosis, black necrosis, fire, progressive cellular inflammation), and formerly as blackleg, sometimes as anthrax and erysipelas, as well as wildseuche and cattle plague.

The symptoms of malignant edema consist of a swelling in the vicinity of the point of infection. This develops suddenly, is edematous, doughy, and very sensitive; it spreads rapidly to the neighboring tissues, and frequently crackles on palpation. The favorite seats of the edematous swellings are in the following places: the tongue, pharynx, laryngeal and parotid regions, the head, throat, and upper limbs, the lumbar and sacral regions. The center of the swelling is usually cool, relaxed and painless; while the periphery is tense, hot, and sensitive. The subcutaneous and submucous connective and fatty tissue, as well as the neighboring muscular tissue, is filled with a gelatinous exudate, and a foul smelling gas. The yellowish-red edematous fluid contains many characteristic edema bacilli and threads, which are not present in the blood during life, and are only occasionally found in the blood after death. In many cases, however, the local symptoms are absent. One also notes high grade dyspnea (edema of the lungs), as well as severe gastric derangements (inflammation of the mucous membrane). The disease usually runs its course in a short time (one to three days), terminating fatally with severe febrile symptoms. When the disease is confined to the head, recovery sometimes occurs. On post mortem the spleen, liver, and kidneys are usually intact; splenic tumors, in particular, are occasionally absent.

The treatment, as in phlegmons, consists in making free incisions—admit the air—the most active opponent of anaerobic bacilli; provide drainage and apply antiseptics. According to an observation of Attinger, warm fomentations appear to be contra-indicated; they favour the extension of the edema. With reference to the literature on malignant edema Cf: Friedberger and Fröhner, "Special Pathology and Therapeutics". Sixth Edition, 1904. Vol., II. Also Kitt: Monatshefte für praktische Tierheilkunde. Bd. VIII.

TETANUS.—This was formerly considered a disease of the nerves characterized by trismus. As a result of the investigations of Nikolaier and Kitasato it was found to be a genuine wound-infection disease, caused by the bacillus of tetanus. It is most frequently observed in the horse after injuries to the hoof (nail pricks, nailing, treads on the coronet), the posterior limbs and the head, after castrations, after operations on the tail (amputation, setting up), subcutaneous injections, removal of setons, entrance of foreign bodies (kernels of grain) into the guttural pouches. It is also observed

in cattle (tetanus puerperalis after injuries to the vagina and uterus, castration, umbilical wounds in calves), sheep and goats (castration, inoculation, seton, umbilical wounds). In dogs, however, tetanus is extremely rare ; two cases have been observed by Möller. Among 70,000 diseased dogs, I have never seen a case of tetanus; the experimental inoculations of garden soil into dogs by Nikolaier also gave negative results. Kitt, on the other hand, was able to produce tetanus in dogs by injecting pure cultures.

The tetanus bacillus (bacillus tetani) is in the form of a rod, shaped like a stick pin, music note, or cooking ladle ; the end contains a spore. It is found everywhere, especially in garden soil, as well as in earth that has been covered with horse manure, it is also found on the floors of horse stalls. As experimental inoculations with ordinary garden soil have proved, infection usually results from the entrance of bacterial earth; other objects may act as intermediate carriers of the tetanus bacillus (horse-shoe nails, splinters of wood, instruments, dust of hay, manure, kernels of grain, cob webs). Conditions for the infection are made more favorable by the simultaneous existence of other microorganisms, especially the pus-forming bacteria (microbes favorisants). In contrast to the bacteria of septicemia and pyemia, the tetanus bacilli do not enter the blood, but remain at the point of infection where they develop a strychnine-like toxin (tetanotox-albumen), which is resorbed by the blood. In the form of tetanospasmin it produces convulsions as a result of its action on the spinal marrow. This toxin contains an unprecedented poisonous ; a dose of 0.00025 grams, equal to ¼ mg., equal to 1-200 of a minum, produces death in the horse ; it is a thousand times more poison than strychnine (lethal dose for the horse—0.25 grams). The toxin is absorbed by the substance of the axis cylinders of the peripheral nerves and carried to the central nervous system. Tetanus, therefore, is to be considered as an infectious disease, in which a general intoxication arises from the local point of infection. Occasionally one observes a seemingly long period of incubation, several days or even weeks (the usual period is from 4-20 days), in which tetanus occurs, for example, after careful disinfection and bandaging of the wound, even after healing and cicatrization are complete. I have observed a period of incubation of even forty days in a horse (Monatshefte für praktische Tierheilkunde. 1902).

The symptoms of tetanus consist in locking of the jaws (trismus) ; convulsive, stiff extension of the head, throat, and back (orthotonus) ; dorsal or lateral curvature of the throat (opisthotonus and pleurotonus) ; stilted, or sawbuck-like position of the limbs ; stiff, extended position of the tail and ears ; pronounced contraction of the compressors of the abdomen ; dyspnoea (spasms of the inspiratory muscles) ; increased reflex irritability ; timidity ; and perspiration. In horses, the course is either very rapid (death after one to three

days), or acute (death after four to ten days); in other cases, especially in the non-frequent cases of recovery, a subacute and even a chronic course is observed (many weeks). One occasionally observes a contagious-like outbreak of tetanus (experience with military horses and in clinics). The mortality in horses is from 50–80%. The post mortem is apparently negative. Treatment is not very satisfactory (local disinfection; removal of the foci of infection, amputation of the tail, for example; removal of external excitants; diatetics). Administration of chloral hydrate, bromide of potash, morphine. The treatment of horses suffering from tetanus with tetanus antitoxin has not proved satisfactory. Antitoxin, on the other hand, has proven useful as prophylactic previous to operations (Nocard, Labat). With reference to the literature on tetanus see: Friedberger and Fröhner, "Special Pathology". Sixth Ed. 1904, Vol. II.

WOUND DIPHTHERIA.—The name wound diphtheria (hospital gangrene, gangrena nosocomialis) indicates a wound infection disease which was formerly very common, but which has become infrequent under the influence of modern antiseptics. It consisted of a coagulation necrosis of the granulations as a result of the action of specific bacteria (necrosis bacillus). The granulations are transformed into a yellowish-red, suppurative, ichorous pulp (croupous and diphtheritic form); or into a grey, pulpy, gangrenous mass (ulcerative form); or into a stinking, putrid and soft mass similar to the pulp of a spleen (pulpy form). Treatment consists of burning early, or cauterization of the wound with chloride of zinc. Bayer has described a case in the horse. The tissue in the region of the parotid glands was transformed into a greenish-brown, fetid mass; the process was accompanied with the formation of the gasses of degeneration, which had produced an emphysematous condition of the neighboring tissues. I have observed similar cases in the horse.

GLANDERS.—In rare cases, wounds in the horse become infected with the bacillus of glanders (primary glanders of the skin). This occurs, especially, on the extremities, abdomen, thorax, shoulders, and head. There then develops from the wound, a crater-like glanders ulcer; it is characterized by tenacious, discolored, frequently hemorrhagic secretions; from the ulcer, wreath-like swollen lymph vessels extend to lymph glands which are also swollen (glandular lymphangitis and lymphadenitis). Lameness exists according to the location of the glandular processes. Occasionally there also develops a chronic glandular phlegmon, which may finally lead to elephantiasis of the extremities and head (glandular pachyderma). I have described one case of this kind in the horse (Report 1883). Richter has described a case of glanders of the eye (glandular keratitis) (Zeitschrift für Veterinaerkunde. 1896). For further information concerning glanders, especially with reference to differential diagnosis of the same, refer to text-books on special pathology.

RABIES.—Rabies is a genuine wound infection disease; the cause of the infection has not yet been discovered; infection gains entrance from the saliva through the medium of wounds caused by bites, and then passes into the body. The bites, themselves, present no special characteristics, as a rule they heal similar to the wounds of tetanus. The acquired virus is sufficient for the development of the disease, the appearance of the first visible symptoms may require weeks, and even months (long period of incubation). According to paragraph 35 of the government laws which refer to animal plagues, no attempts can be made to cure animals affected, or supposed to be affected, with rabies; animals affected with rabies must be killed immediately (paragraph 37); those supposed to be affected must be killed or confined (paragraph 34). In man, treatment consists in cauterization, cutting out the wound, as well as in the application of strong disinfectants (sublimate, creolin, aqua chlorata, calcium permanganate, etc., carbolic acid is unefficient).

BLACKLEG.—This is also a wound infection disease in which the blackleg bacillus gains entrance to the wound only through injuries to the skin and mucous membranes (the subcutis and submucosa). Blackleg, therefore, may be considered as a specific phlegmon of cattle, similar to malignant edema. It is characterized by edematous swellings of the skin which develop rapidly and crepitate, the centers of these swellings undergo necrotic degeneration, they are located on the upper parts of the limbs, the throat, the shoulders, the inferior surface of the thorax, etc., the motions of the animal are also deranged; there are swellings in the regional lymph glands; severe general symptoms, and high fever are present. The course of the disease is usually rapid, terminating fatally in from one to three days. Treatment of the area of infection is usually too late (incision, disinfection amputation, ligature). The so-called puerperal blackleg of cattle is usually, not a case of genuine blackleg, but partly a gas phlegmon, partly a malignant edema (Carl); sporadic cases of genuine puerperal blackleg have been identified by Rievel, Olt, and Ostertag. For further information concerning blackleg see textbooks on special pathology, as well as Kitt, Monatshefte für praktische Tierhielkunde. VIII.

ANTHRAX.—In contrast to man, anthrax is rarely a wound infection disease in animals. In addition to the ordinary infection through the intestines, one occasionally observes sporadic cases of entrance of anthrax bacilli through wounds in the skin and mucous membranes, after previous operations (castration), bites, or punctures from insects. There exists, first, a local inflammatory focus in the skin and mucous membranes (anthrax carbuncle, anthrax edema) this is followed by a rapid general infection, which usually has a fatal termination. Cases of anthrax of the skin and mucous membranes were formerly described under the names, carbuncle disease, boil

fever, anthrax of the tongue, anthrax of the gums, and morbus carbuncularis.

WILDSEUCHE.—The so-called exanthematic form of wildseuche exists apparently through the entrance of infectious material into small wounds of the skin or mucous membranes (injuries from the twitch, accidental injuries), and is, therefore, considered a wound infection disease. It is characterized by pronounced edematous swelling of the skin and mucous membrane, as well as the subcutis and submucosa of the head, the oral cavity, the submaxillary region, throat, etc., there also develop symptoms of septicemia hemorrhagica. Death usually occurs after 12–36 hours. Details concerning wildseuche may be found in text-books on special pathology.

STRANGLES.—Strangles usually develops from the mucous membranes of the respiratory and digestive apparatus. Occasionally there occurs a strangles infection from wounds, whereby the regional lymph glands are involved first. A case of this type has been described by Litfas (Berliner tierärztliche Wochenschrift. 1895). I, myself, have observed two cases.

With reference to other wound infection diseases (actinomycosis, botryomycosis, tuberculosis, lymphangitis, phlebitis, petechial fever) compare with the chapters on these subjects.

WOUND INFECTION DISEASES OF THE VETERINARIAN.—The following are the various wound infection diseases against which the veterinarian should be guarded: phlegmons, lymphangitis, and erysipelas, septicemia and pyemia, eczema on the hands and arms (obstetrics), anthrax, glanders, rabies, botryomycosis, tuberculosis. Among 365 officials in the Berlin Abbatoir and Stock Yards (veterinarians, butchers, etc.), 7 had inoculations with tuberculosis on the hands, 3 had questionable nodules (Lassar).

VI. TREATMENT OF WOUNDS.

ANTISEPTIC AND ASEPTIC TREATMENT OF WOUNDS.—Lister is the founder of the modern treatment of wounds. Working on the theory that wound infection might be prevented by the application of antiseptics, as well as careful bandaging, he employed, in 1867, carbolic acid with a bandage; the latter being termed a Lister Bandage. This Lister bandage is applied as follows: irrigate the wound with a 2–5% solution of carbolic acid; spray the surrounding air

with the same solution ; cover the wound with a piece of carbolized silk or surgeons cotton (silk or cotton protective); place over this a thick layer of carbolized gauze or other carbolized dressing ; over this is placed an impermeable layer of surgeons cotton (mackintosh); the whole is retained by means of a moist, carbolized gauze bandage. Between the years 1872–1875 the Lister bandage was in general use in Germany. Later the use of the spray was dropped and the simple bandage applied. In 1880 the dry iodoform pack supplanted the use of the carbolic acid. Since then, other disinfectants have partially taken the place of iodoform (sublimate, creolin, lysol, tannoform, and other disinfectants).

In recent times the use of antiseptics in human surgery has been restricted, in some cases even suspended. Schimmelbusch and others claim that when a wound has been infected for no longer than one minute there is no certainty of destroying the bacteria with disinfectants. There is no object, then, in disinfecting the wound, it is even harmful, because the tissues are irritated and the wound secretions are increased. Antiseptic treatment has, therefore, given way to the aseptic method, which is carried out as follows : the wound is made as dry as possible with the use of a sterilized towel, and without the application of antiseptic fluids ; it is irrigated only with sterilized water, or sterilized physiological salt solution (0.6%), and then covered with a sterilized bandage. The material is sterilized in a specially prepared apparatus, it is exposed to steam of not less than 100° C., for a period of twenty to thirty minutes ; the instruments are sterilized in the same manner. Boiling for a long time in a one or two per cent soda solution is one of the surest methods of sterilization. Special care is taken with reference to disinfection of the hands of the operator. After the dirt has been thoroughly removed from the nails, the hands are brushed with soap and water, then washed in warm sublimate, carbolic, or creolin water, and finally rubbed in a fifty per cent alcoholic, or alcohol and soap solution. The following must also be rendered aseptic : the operating field, operating table, clothing of the patient, operators, assistants and helpers, all utensils that are used, as well

as the operating field in the vicinity of the wound. Even operating gloves, and masks for the mouth and nose are employed as aseptic protectives.

The aseptic treatment of wounds in human surgery has many advantages. Healing follows the natural self-protection of the tissues (leucocytes, blood-serum), and there are only slight changes from external interference. Recently, many surgeons have changed from the purely aseptic method to the antiseptic; since Henle and others, contrary to the conclusions of Schimmelbusch, have demonstrated by means of statistics that local disinfection of the wound is possible within the first few hours, and that the results of the aseptic method are no more satisfactory than those of the antiseptic. Bruns even employed pure carbolic acid to disinfect the wounds, Küster used the hot iron (Berlin Surgical Congress, 1901). Antiseptic surgery involves the very difficult, or impossible, disinfection of the hands, which is not improved by the use of sterilized operating gloves (Berlin Surgical Congress, 1898).

Up to the present time aseptic surgery in veterinary science has received a very limited use. I have already mentioned this fact in the first edition of this book. The veterinarian deals mostly with old, infected wounds, in which, not asepsis, but thorough antisepsis, is necessary. Even fresh operation wounds can seldom be given aseptic treatment, for example, in a clinic. Even in a well equipped veterinary hospital the aseptic surgical treatment of horses offers the greatest difficulties. Bandages can be applied only to a limited extent, in some cases it is almost impossible to prevent infection during the operation. When compared with human surgery, infection through the air plays a more important part (dust, hair), against which asepsis is of no use. For these reasons, the antiseptic method is to be preferred to the aseptic in veterinary science.

ANTISEPTICS.—In selecting and deciding upon the various therapeutic agents to be used in the treatment of wounds, a general point of view comes into consideration. In the first place, besides the disinfecting properties of the various ma-

terials, we must consider the resistance of the organisms in the wound. This resistance lies, as I have fully explained elsewhere (Lehrbuch der allegemeinen Therapie), about midway between the very resistant anthrax spores, and blackleg bacilli at one extreme ; and the easily destroyed anthrax and swine erysipelas bacilli at the other. The streptococci and staphylococci, especially, should not be fought with weak disinfectants; their destruction requires stronger antiseptics (sublimate, creolin, lysol, tannoform, carbolic acid, solution of aluminum acetate, nitrate of silver). The toxic action of the antiseptics must also be considered, their irritating action on the wound, their decomposition by the secretions of the wound, their strength and form, the price, and the state of healing. In general the following rule should be adopted : employ disinfectants which are active, not too irritating, not easily decomposed, non-poisonous, reasonably active in aqueous solution, prompt in their action on the wound (tannoform). Actual disinfection should be preceded by careful irrigation. The following descriptions refer to the more important disinfectants (detailed descriptions are found in my Lehrbuch der Arzneimitellehre, 6. Aufl.).

SUBLIMATE.—This is our most powerful and poisonous disinfectant. A 1-1000 sublimate solution quickly destroys all bacteria involved in wound infection. With the exception of ruminants it can be employed on all domestic animals. In cattle sublimate acts as a specific poison, for this reason one must be guarded in its use. When combined with albumenous wound secretions it partly precipitates in the form of an albumenate of mercury, partly decomposes (formation of oxychloride of mercury). The decomposition has no material influence on its antiseptic action ; decomposition may be prevented by the addition of sodium chloride (pastil of sublimate). The advantages of sublimate are : its strong antiseptic properties, non-odor, cost, convenience (sublimate tablets). The disadvantages of sublimate are : pronounced toxicity, especially for cattle ; irritability, especially on the mucous membranes of the eye (ophthalmology), and the uterus (obstetrics); it also rapidly amalgamates the instruments. In France, in the place of sublimate, hydrargyrum biniodidum rubrum is employed in a solution of

1 : 10,000 to 1 : 20,000; it is more active and less irritating. Many also prefer hydrargyrun cyanatun to sublimate because it does not amalgamate the instruments.

CREOLIN, LYSOL, BACILLOL, AND OTHER CRESOL COMBINATIONS.—The antiseptic action of the cresols is pronounced and rapid. A 3% solution destroys wound infection organisms. The disinfectant properties of cresol are apparently stronger than those of carbolic acid. It further possesses deodorizing properties; it is relatively non-poisonous, and inexpensive, its disadvantages are: odor, irritating action of strong solutions on the mucous membranes, gradual destructive action on rubber tubes, cloudiness of the solutions.

CARBOLIC ACID.—The action is relatively strong. Most bacteria die after a long time in a 3% solution. The official carbolic acid solution is mixed in a 4% solution. The action of carbolic acid seems to be slight towards the infectious material of tetanus, rabies, the tubercle bacillus, and the spores of anthrax. Castration clamps, for example, transmitted tetanus after eighteen months, notwithstanding the fact that they were placed in a 4% solution of carbolic acid for five minutes (Nocard). Advantages: its strength is constant and it does not decompose. Disadvantages: cost, odor, irritating and toxic action, especially the latter, for cats.

IODOFORM.—This is an excellent, mild stimulator of granulations; also used in etherial solutions 1:5–10). Disadvantages: odor, cost, toxicity for dogs (licking), insolubility in water. The following similar preparations from iodine are expensive; for this reason they are not much employed in veterinary surgery: lorentin, losophan, iodophen, europhen, aristol, iodoformin, iodoformogen, iodol, iodtrichlorid (easily decomposed). In actinomycotic infections, iodine and iodide of potash in aqueous solution (Lugol's solution) is a specific for actinomycotic infection.

TANNOFORM.—At the present time this is our best aseptic covering and dry antiseptic. Applied early to cuts, it checks suppuration (healing under an eschar). In horses it is preferable to iodoform on account of being a more active and non-odorous antiseptic. Other formaldehyde preparations are: glutol, amyloform, and others; they are more expensive and their action is less constant than that of tannoform. Formaldehyde, itself, in a 1 to 2% solution is a strong disinfectant, it irritates the wounds however; it is very caustic when concentrated (caution!).

NITRATE OF SILVER.—This is an excellent wound dressing. It is a strong disinfectant (a 1 : 100 solution is fatal to pus cocci). It is a valuable regulator of abnormal granulations, and leaves a protective covering in the form of an eschar (eschar of silver). The same is true of the more recent but very expensive preparations of silver (argentum lacticum and citricum, actol, itrol, protargol, ichthargan).

SOLUTION OF ALUMINUM ACETATE.—This is an excellent non-toxic antiseptic in a 2–8% aqueous solution (also contained in Burrow's solution); because of the expense it is preferable to the more costly substitutes: alumnol, tannal, gallal, sozal, boral, salumin, cutol, etc.

BISMUTH SALTS.—These are absorbing, astringent, dry antiseptics; their action is similar to tannoform, they seem to be more expensive, however. The following are most often employed: bismuth subnitricum, subsalicylicum, gallicum (dermatol), dithiosalicylicum (thioform), airol (iodid of dermatol). The latter in the form of AIROL PASTE is an excellent aseptic protective covering for wounds; it is non-irritating, easily applied, dries rapidly, and is very adherent.

ALCOHOL.—This is an important agent for disinfecting the hands of the operator and the skin of the operating field. It is best employed in the form of a 50% aqueous solution or aqueous solution of sublimate (absolute alcohol has only a weak antiseptic action). Alcoholic soaps are also employed. Alcoholic TINCTURE OF ALOES stimulates granulations on old wounds and is an active antiseptic. TINCTURE OF IODINE is an excellent disinfectant for infected wounds that have a tendency to necrosis.

SALICYLIC ACID.—A weak antiseptic, it is non-poisonous however, odorless and non-irritating. It finds application in ophthalmology, in irrigation of the internal organs of the body, and in the treatment of cats. Thioform (bismuth dithiosalicylate) is a substitute for iodoform. It is especially employed because of its non-odor and non-toxicity (very expensive!).

BORIC ACID.—A mild, non-toxic, and odorless antiseptic; its action is slight (ophthalmology, irrigation of the uterus). The following, with other solutions of boric acid, possess a similar action: borax and borate of magnesia, boral, antipyonin, rotterin, antiseptin, borol.

CHLORIDE OF ZINC.—A caustic antiseptic (2-8% solution), its action as an antiseptic is relatively weak (common agent for abnormal granulations).

CALCIUM PERMANGANATE.—Weak antiseptic. Specific against snake bites and the toxin of rabies.

CAMPHOR.—A powerful antiseptic, especially for torpid granulations, phlegmons, and necrotic processes (spirits of camphor bandage). Those agents which have a similar action are: oil of turpentine, turpentine (old hoof remedies), thymol oil of eucalyptus, balsam of Peru, and other etherial oils.

TAR.—An excellent antiseptic, especially for wounds of the hoofs and claws. Wood tar is preferable to coal tar.

AQUA CHLORATA.—Strong antiseptic. Specific for rabies and snake bites. Employed in ophthalmology.

PYOCTANIN.—Active antiseptic. Disadvantages: blue color.

HEAT.—By means of high temperature pus bacteria die in ten minutes at a temperature of 55–62°, the streptococcus of strangles at 60°, the tetanus bacillus at 75°, the spores of tetanus at 100°.

OPEN WOUND TREATMENT AND BANDAGING.—If a wound is aseptically or antiseptically handled, and eventually sutured, a bandage should be applied wherever possible. It protects the wound from the entrance of infection (air, and contact infection), as well as irritants. The bandage should be dry. Such a bandage is termed a dry, aseptic wound bandage. A moist antiseptic bandage is better for extensive wounds, pronounced suppuration, phlegmons, preparation of certain portions of the body for operating, etc. The moist bandage combines protection with a continued antiseptic action; it neutralizes the action of the wound secretions; the moist warmth assists granulation and cicatricial formation. Through maceration of the skin and horn it may occasionally become injurious. When a bandage is not changed for a long time it is termed a permanent bandage. Other forms of bandages are: simple, Lister, pressure, dry dressings, ointment and tar bandages, iodoform bandages, antiseptic tamponade, etc. With referance to bandage materials and bandage technique see: Bayer, Operationslehre. Only the most important rules for bandaging are given here. These are: 1. Every wound, when possible, should be bandaged. 2. The bandage should, after aseptic operations, remain in position as long as possible (following resection of the lateral cartilage, for example, fourteen days). 3. The bandage must be changed, however; (a) when it becomes saturated with pus, wound secretions, or filth; (b) when improperly applied; (c) when there is pain or pronounced swelling in the vicinity of the wound, or when fever exists.

In veterinary practice the open treatment of wounds must often replace bandaging. This is especially true of horses and cattle, in which the application of a bandage in various parts of the body is impossible (gluteal region, upper limbs). In such wounds the oxygen of the air acts as a

disinfectant; it is of special value in malignant edema. For this reason, the suturing of old or large wounds is contra-indicated. The aseptic wound bandage is most readily applied to dogs. When a bandage cannot be applied healing under eschar may occur (dry or moist blood-eschar; necrosed eschar; one formed by tannoform, tannin, silver nitrate, dry dressings, etc.). Ointments may take the place of a bandage (boric acid, silver nitrate, decubital salve, etc.). Adhesive remedies perform the same function (airol paste, iodoform-colodion, zinc paste, bismuth paste, adhesive plaster). In many cases, as in human surgery, permanent irrigation is employed with good results, that is, the wound is irrigated for a long time with an antiseptic fluid. Immersion (water bath) has a very limited field of application (hoof baths, baths for mange). Antiseptic cataplasms are employed to encourage the sloughing of necrotic tissues in hoof injuries, fistulous withers, etc., (linseed meal bandage with creolin water). The application of linseed meal to any wound is not considered good surgery at the present time (Translator).

TREATMENT OF THE DIFFERENT KINDS OF WOUNDS.—1. Fresh incised, punctured and lacerated wounds or bites are treated as follows: arrest the hemorrhage; irrigate; disinfect; and drain; apply an aseptic tampon; suture as much as possible; and when practical, apply a bandage.

2. Contused and old, especially suppurating wounds, are not sutured; otherwise they are treated as fresh incised wounds. In many cases of small, old, suppurating wounds, healing by third intention is possible; the modus operandi is as follows: trim the margins, irrigate carefully for a long time, disinfect, remove all necrotic portions, bring the margins of the wound in close apposition by means of sutures (wounds of the head in the horse). When removing foreign bodies or destroyed tissues from contused wounds care should be taken not to remove the sound tissue also. This is particularly true of flap wounds (treads on the coronet), where the retention of small flaps of skin is of greatest importance. Contused wounds with pronounced suppuration and tissue necrosis are best treated by means of moist bandages; as open wounds; or with permanent irrigation.

3. Shot wounds are treated according to the same rules of asepsis and antisepsis as those employed for the treatment of ordinary wounds.

As experience in men has proved that bullets are frequently encapsuled, expective treatment should usually be followed, do not favour extraction of the bullet (v. Bergman, Kocher). Probing of the wound is also superfluous; when the finger or probe are not carefully disinfected it is even dangerous to life (keep the finger and probe away). Shot wounds are best treated as follows: antiseptic occlusion and tamponade; or drainage without suture followed by a bandage. If for certain reasons it seems necessary to extract the bullet (phlegmons, pain, high fever, etc.), a simple incision is often all that is necessary; employ foreign-body forceps, curette, etc., in place of special bullet forceps.

4. Joint wounds, when fresh, should be carefully disinfected; sutured; and when possible, covered with an aseptic occlusive bandage. It is not always possible to bandage perforating joint wounds in horses and cattle; in those cases one may use iodoform-collodion, airol paste, and other adhesive materials, the cautery may be used to close the wound with a necrotic eschar, permanent irrigation is also employed. The earlier employed caustic applications in the vicinity of the joint (closure of the wound by swelling) are of little value. Suppurating joint wounds in dogs may be drained, irrigated, incised if necessary, and packed with an antiseptic tampon. In horses and cattle they are frequeutly incurable.

5. Perforating abdominal wounds require careful antisepsis; reposition of the intestines after thorough disinfection; ligation and removal of the prolapsed omentum, as well as a double suture.

6. Poisoned wounds (snake poison, rabies, etc.) may be excised; cauterized; burned; or treated with specific disinfectants; potassium permanganate, aqua chlorata, liquor ferri chloridi, and calcium bichromate in the form of subcutaneous injections.

7. Wounds that are granulating abnormally are treated with the knife, curette, cautery, caustics (nitrate of silver and chloride of zinc), ointment bandages, tincture of aloes, etc. See treatment of ulcers.

TRANSPLANTATION.—This was first employed by Reverdin, in the year 1870. It was employed in human surgery to provide a rapid covering for granulating wound surfaces. Thiersch also had a broad experience in the transplantation of epidermis. Formerly, pieces of skin, the entire thickness of the epidermis, were transplanted. At the present time the modus operandi is as follows: the rules of asepsis are very carefully observed; very thin, superficial sections of the skin are removed with a razor, they extend, however, to the papillary bodies; these sections are about the length and breadth of one's finger, they are removed from the upper arm or limb, and are transferred from here to the granulations. The granulations have been previously freshened

with a curette, the flaps of skin are applied without coming in contact with any antiseptics (necrosis of the epidermis), they are carefully retained in position by means of sterilized tin foil, a dry or moist bandage (salt solution) is employed for protection. If the transplantation is successful the pieces of skin heal to the granulations by first intention; about the third day they are vascularized by vessels from the granulation tissue; and the wound is covered through the formation of new epidermis from these artificial islands of skin. A simpler method consists in the removal of the epidermis only, from the healthy skin, this being placed on the granulations. It is also possible to transplant mucous membrane on mucous membrane, as well as pieces of bone with periosteum and marrow from living young animals to man. On the other hand, the transplantation of nerves, muscles, and tendons, from animals to man has not yet been successful.

The difficulties of transplantion consist in the prevention of death of the removed piece of skin on the one hand, and the difficulty of fixing it to the granulation tissue on the other. The latter is especially difficult in animals. Mamadyschski has been successful in horses and dogs with Krause's method of transplantation. Querruau has successfully treated saddle pressure in the horse by means of transplantation. Bayer, on the other hand, has repeatedly employed transplantation in horses without results; the great mobility of the skin of the horse hinders exact fixation of the flaps, while the firmness and non-vascularity of the same does not favour rapid growth. Bayer has even retained the flaps by means of sutures and needles without results. Also, the hair on the skin of animals often retards growth. On the other hand, the transplantation of skin and mucous membrane from animals to man is successful; the same is true of the transplantation of spurs to the comb of a cock.

SUBCUTANEOUS INJURIES OF THE SOFT PARTS (CONTUSION, LACERATION).

1. CONTUSION.

DEFINITION AND CAUSES.—In contrast to wounds of the skin and mucous membrane, which are always accompanied by a breach in their continuity, a contusion is an injury to the soft parts without an external wound. It is caused by pressure from a blunt instrument, the skin, because of its elasticity, remaining uninjured, while the underlying soft parts, especially those covering bone are torn. Contused wounds and contusions are due to the same

causes. In every other way they are different, namely, symptoms, course, treatment, and prognosis. This is due to the fact that contused wounds are open to infection, while in subcutaneous injuries of the soft tissues the paths of infection are closed.

The causes of contusions in the domestic animals are various. In horses they are caused by pressure from the harness, saddle, bit, shoe, faulty nailing of shoes (corns, nailing), calks, kicks, blows, and falls, entering doors, self-inflicted injuries from treads on the coronet, decubitis, etc. In cattle they are caused by horn-thrusts. Bites and chastisements frequently produce contusions in dogs.

GRADE OF CONTUSION.—According to the severity and extent of subcutaneous injuries, different grades of contusions are recognized; differentiation being based on the injuries to blood-vessels. The simplest division is that which separates a contusion with preservation of tissue from one that results in necrosis. According to the extent of hemorrhage the first may be further subdivided into contusions with slight or severe hemorrhage. In general, therefore, three grades of contusion are recognized:

1. Contusions of the first grade are characterized by a slight amount of hemorrhage. The extravasate may be evenly distributed through the contused tissues (bloody infiltration), or it may occupy small circumscribed foci (ecchymosis, petechia).

2. Contusions of the second grade lead either to large subcutaneous accumulations of blood (hematomata), there are also alleged to be circumscribed effusions of large quantities of lymph (lymph-extravasate), or to a superficial accumulation of a large amount of blood (suffusion).

3. Contusions of the third grade result in gangrenous death of the involved tissues (necrosis, mortification). The cause of death is due to the deranged circulation brought about by extensive injuries to the blood-vessels (primary anæmic necrosis). Necrosis may also be due to entrance of infection from without or through the blood-stream

(secondary septic necrosis). Experimental investigations have proved that the contusion of itself does not cause necrosis.

Complete crushing of the contused parts is sometimes termed a contusion of the fourth grade.

MICROSCOPIC CHANGES IN CONTUSIONS.—The following conditions are found in contusions that are experimentally produced in animals: In contusions of the first grade only a laceration of the loose connective tissue, that which is supplied by the smallest blood-vessels. In contusions of a severe grade there is also laceration of the intercellular substance of the tissues, so that the cells are separated from one another. In the severest crushing of the tissues, however, the cells usually remain unimpaired. This explains the fact that crushing, alone, does not result in necrosis (Gussenbauer).

SYMPTOMS.—Swelling, due to hemorrhage, is the most important symptom (contusion swelling). In contusions of the first grade (bloody infiltration) the swelling is small and diffuse. Large circumscribed swellings characterize second grade contusions (hematomata). Hematomata on the hind limbs of horses become especially large (larger than one's head); I observed one case in the region of the udder in a horse in which the hematoma contained 25 liters. Contusions may occur in the following places: skin, mucous membrane, subcutem, subfascia, intermuscular tissues, in the vicinity of joints, within joints (hemarthrosis), in the tunica vaginalis (hematocele, etc.). Superficial excoriations sometimes occur on the skin over the contused area. As long as the contused swelling contains nothing but extravasate, without any material injury to the skin, and no infection from without, inflammatory symptoms are absent. This is true of hematomata and is an accurate means of differentiating between a hematoma and an abscess. The consistence of the swelling is usually softer, fluctuation is pronounced, on palpation crepitation may be noted (coagulum of blood). When the contused tissues are rich in nerves, pain may accompany the swelling. This causes lameness when the seat of injury is in the following regions or tissues: hoof, periosteum, muscles, and nerves. Severe contusions of the nerves, spinal cord, and brain lead to paralysis, insensibility, and unconsciousness. A reflex paralysis of the central nervous system may result from severe peri-

pheral contusions (so-called shock). General symptoms are usually absent. Symptoms of anæmia are observed only in rupture of large blood-vessels. Resorption of extravasate from severe contusions may be followed by febrille symptoms (aseptic resorption fever), and swelling of the lymph-glands. Fat emboli of the lungs have occurred in man. Inflammation as a result of contusion may result in suppuration and necrosis, it may also assume the form of septicemia.

COURSE.—The termination of the blood-extravasate depends upon its size, the degree of contusion, and the infection or non-infection of the wound, it is, therefore, variable. The blood may become resorbed, or encapsuled, organization, suppuration, or necrosis may also occur.

1. Resorption, that is, the absorption of the extravasate through the lymph-vessels, usually follows subcutaneous contusions of the first grade; small hematomata are occasionally absorbed in the same manner. The component parts are resorbed in the following order: the blood-serum, the dissolved fibrin, the degenerated white blood-corpuscles, and finally the red blood-corpuscles; the latter are resorbed partly in toto, partly in a degenerated condition. The resorbed red blood-corpuscles sometimes accumulate in the lymph-glands to such an extent that the latter have an appearance of dark-red swellings. Red blood-corpuscles which remain in the contused areas undergo granular degeneration and give off their coloring matter. The latter is diffused in the surrounding tissues and is transformed into a crystalline hematoiden or a soluble choleglobin out of which are developed coloring matters similar to those found in the gall; green, red, blue, and black (melanin) (Latschenberger). These are visible only in unpigmented skin where they appear in the form of so-called black and blue spots. Later they are resorbed and disappear.

2. Organization and encapsulation, so-called, occur in relatively large hematomata. In the vicinity of the hemorrhagic focus there exists, as a result of proliferation of the autochthonous tissue cells, a cellular infiltration with the formation of fibrous connective tissue. This gradually dis-

places the extravasate and, similar to the so-called organization of a thrombus, forms a connective-tissue induration as the product of an aseptic, interstitial inflammation (tumor fibrosus). When the connective-tissue mass does not displace the extravasate, but the inflammatory process runs a chronic aseptic course around its periphery, as around foreign bodies, the extravasate finally becomes encapsuled by a connective-tissue membrane (blood-cyst, hygroma). This process of cystic formation is frequently observed in dogs. I have observed one case in which the capsule developed in fourteen days. In the horse one occasionally finds small, moveable blood-cysts located subcutaneously in the region of the withers, as well as subcutaneous hygromata with free bodies (corpora libera). Caseous incrustations, even cartilaginous and osseous degenerations, may result from the organization of a hematoma (othematoma in dogs, subperiosteal hematomata).

3. Suppuration and ichorous ulceration in contused swellings is only the result of the entrance of infectious material into the blood-extravasate. A hematoma then, may terminate in an abscess, under certain conditions the abscess may become encapsuled (shoulder abscess). Diffuse bloody infiltrations terminate in phlegmons, necrosis may develop during the course of the latter and, in case of complications, pass into septicemia or pyemia.

DIFFERENTIAL DIAGNOSIS.—Contusions run an extremely variable course, they may become complicated with wound infection diseases, and they are often confused with other surgical affections. One must consider tumors, phlegmons, hernia, and fractures (crepitation). It is of great practical importance to differentiate between hematomata and abscesses. One must remember that hematomata develop suddenly over their entire area ; abscesses develop slowly. A genuine hematoma is not characterized by inflammatory symptoms nor general febrile conditions. The periphery of an abscess is hard, that of a hematoma is fluctuating. In doubtful cases one may use the exploratory probe.

TREATMENT.—The treatment of contused swellings is variable; it depends on the degree of the contusion.

1. Slight, circumscribed blood-extravasates may be treated with massage, moist heat, and compression, as well as counter-irritants. The object being to bring about resorption.

2. Large hematomata are best treated by means of an incision, this should not be made too early. Extirpate encapsuled blood-cysts; aspiration, with a subsequent injection of tincture of iodine is sometimes effectual. Encapsuled hematomata and hygromata may occasionally be ruptured with force.

3. Necrosis, phlegmon and abscess formation should not be treated with massage. Suppurative and necrotic inflammations are treated according to the rules of antisepsis; incise, remove the necrotic tissue, drain, and disinfect.

THE MOST IMPORTANT CONTUSIONS OF DOMESTIC ANIMALS.—The following affections are of special practical importance:

1. Contusion of the neck, withers, on the saddle position, point of the shoulder, on the sternum, and in the vicinity of the shoulder in the horse (poll-evil, fistulous withers, saddle galls, sternal and shoulder abscess).

2. Contusions of the upper and under lips (twitch), the skin at the angle of the mouth (bit), and the mucous membrane of the interdental space of the inferior maxilla in the horse.

3. Contusions of the external angle of the ilium, orbital, process, zygomatic region, etc., especially in horses and cattle (decubitis).

4. Hematomata in the gluteal region, especially in the region of the buttocks, on the anterior surface of the carpal joint, and on the inner surface of the metacarpus in the horse.

5. Bursitis intertubercularis and trochanterica in horses.

6. Contused swellings on the elbow in the horse and dog (shoe-boil). In dogs they may occur on the neck, or at the tuberosity of the ischium.

7. Contused swellings on the anterior surface of the carpal joint in horses and cattle, especially in working oxen (knee tumor).

8. Contused swellings over the tuberosity of the os calcis in horses (capped hock); the same on the posterior surface of the os calcis (curb).

9. Treads on the coronet, contusions of the pododerm at the angle of the sole (corns), as well as contusions of the balls of the hoof (sore heels).

10. Hematomata in the vicinity of the udder, anterior and posterior in cattle (milk-vein, posterior abdominal vein).

11. Hematomata and blood-cysts on the throat and back of dogs.

12. Hematomata on the inner surface of the ear muscles in dogs (othematoma, hematoma auris).

LYMPH EXTRAVASATE.—This name applies to contused swellings which are not filled with blood, but with lymph; they are due to laceration of large lymph-vessels (lymphorrhea). According to Gussenbauer they occur when, as the result of a contusion, the skin is raised from the underlying parts (fascia) and slides over the firm subcutaneous structures. In contrast to hematomata, lymph-extravasates result in swellings which develop slowly, so that growth is observed for weeks and even months. The effusion of lymph does not coagulate as long as the skin remains intact. On account of chronic development and inability of thrombus formation, as well as resorption, the prognosis is unfavorable. Hoffman has described two cases in the horse (buttocks); he also mentions having observed one case in the cow and dog (ear). Hoffman further refers the so-called knee tumors in horses and cattle to extravasations of lymph. Möller and Bayer contradict the occurrence of pure lymph-extravasates on the posterior limbs of horses and on the ear muscles of dogs; they point out the possibility of a confusion with hematomata. I, myself, have not yet observed a lymyh-extravasate in either the dog or horse.

II. LACERATION (RUPTURE).

MUSCLE RUPTURE.—This term indicates a subcutaneous break in the continuity of individual muscles as a result of

severe stretching and tension of the muscles, it is due to blunt forces from without, or pronounced muscular contraction (spontaneous rupture): distinguish between this and open muscular wounds. The rupture may be complete or incomplete. Diseased muscles are predisposed to rupture (idiopathic muscle-rupture). The symptoms are deranged mobility, the presence of a space or blood-extravasate at the point of rupture, and a hernia (abdominal muscles). Healing follows through resorption of the blood-extravasate and the formation of a connective-tissue cicatrix; there frequently remains a shortening of the muscles (muscle-contracture). Ruptures of abdominal muscles in large animals are usually incurable (ventral hernia). Treatment consists in the application of a pressure bandage whenever possible. In dogs a skin incision may be made and the muscles sutured. Muscle-ruptures are usually seen in horses and cattle. They most frequently occur in the following places: the tibialis anticus, the rectus, obliquus and transversus abdominis; the quadriceps femoris (especially the vastus lateralis); the gastrochnemius; gluteal; the biceps brachii and femoris; the anconeus; the levator humeri; pectoralis minor; longissimus dorsi; psoas; gracillis; infraspinatus; and tensor fascia lata.

TENDON RUPTURE.—Tendon-ruptures also, should be distinguished from tendon-wounds, they are subcutaneous breaks in the continuity. The causes are identical with those which produce muscle-rupture. As a rule they are of external origin (overextension). They may, however, be due to an inner predisposition, such as diseased tendon following inflammation, deranged nutrition, or necrosis (idiopathic ruptures of tendons during the course of suppurative inflammations of tendon-sheaths, or contagious pleuropneumonia). Complete and incomplete (partial, fibrillar) ruptures are recognized: with reference to the latter, see chapter on inflammation, this being the most frequent cause. Complete tendon-ruptures in the horse most frequently occur in the flexor pedis perforans, flexor pedis perforatus, flexors of the

metatarsi, and suspensory ligament; the extensor pedis and achilles tendon are seldom ruptured. In cattle and dogs the flexor metatarsi and achilles tendon are most often ruptured. The symptoms of tendon-rupture consist in a peculiar lameness, as well as the occurrence of a space between the ends of the ruptured tendon (this is not present in rupture of the tibialis, and flexor pedis tendon in the hoof). On anatomical examination one finds a blood-extravasate in the vicinity of the rupture, the ends of the ruptured tendon are fibrous, and covered with blood. Healing follows resorption of the blood, through the formation of a connective-tissue cicatrix from the tendon-sheaths, the paratendineum, and the interfasicular connective tissue; this afterwards takes on the character of tendon-tissue and may finally lead to tendon-contracture. Treatment consists in the application of a plaster-of-Paris bandage; in dogs a tendon-suture may be applied (compare with the chapter on diseases of the tendons).

RUPTURE OF FASCIA.—Subcutaneous rupture of fascia may lead to the formation of a so-called muscle hernia, that is, to the protrusion of a portion of the muscle through the rent in the fascia. I have observed many cases in horses on the posterior limbs, on the neck, and on the shoulder (hernia of the semimembranosus and levator humeri). With reference to rupture of vessels, nerves, and articular ligaments refer to the chapter on diseases of the vessels, nerves, and joints.

INFLAMMATION.

I. NATURE AND CAUSES.

NATURE.—Inflammation is a highly complicated reactive process in irritated tissues. According to the investigations of Cohnheim, v. Recklinghausen, Pfeffer, Metchnikoff, and others, the principal changes are as follows:

1. The irritation of peripheral centers of circulation produces, reflexly, a vasodilitation

(vasodilators) of the arteries, veins and capillaries of the involved tissues; this is the first change that occurs.

2. Acceleration of the blood-stream occurs with the vasodilitation. This is soon followed by a diminished velocity in the flow of the blood; finally the flow of the blood is entirely suspended (stasis).

3. When retardation of the blood-stream occurs, the white blood-corpuscles are arranged next to the vessel walls, especially in the veins; while the red blood-corpuscles occupy the center of the stream. At this period the white blood-corpuscles pass through the walls of the vessels (Migration) in the direction of the irritant (chemotropismus, chemotaxis, phagocytosis), whereby cellular infiltration of the inflamed tissue occurs.

4. As a result of changes in the vessel walls there occurs an active transudation of blood-serum through the diseased walls of the vessels (inflammatory transudate, exudate), occasionally there is also a passage of red blood-corpuscles through the capillary walls (diapedesis). In this way the so-called inflammatory swelling is produced.

5. Finally, in addition to the emigrated white blood-corpuscles, the fixed autochthonous connective-tissue cells proliferate (division, proliferation) and take part in the inflammatory process, especially in the cellular infiltration.

THEORIES OF INFLAMMATION.—According to recent theories on inflammation the primary process is the irritation of the local vasomotor nerves; the secondary process is the migration of the white blood-corpuscles according to the law of chemotaxis, as well as the changes which take place in the vassel walls (v. Recklinghausen). The importance of chemotaxis for the process of emigration of the white blood-corpuscles has been clearly demonstrated by Pfeffer. Formerly the primary, essential processes were supposed to be the changes in the walls of the vessels, the inflammatory exudation, and the migration of the white blood-corpuscles (emigration theory of Cohnheim). Metchnikoff demonstrated the phagocytic theory whereby the white blood-corpuscles form a protection against the entrance of inflammatory irritants by migrating and de-

stroying them (devouring cells). According to Metchnikoff inflammation is merely a "phagocytic reaction" with certain attendant symptoms. Among the old theories of inflammation, the humoral, cellular and neural theories are of historical interest. Virchow established the cellular theory of inflammation, according to which, the inflammatory stimuli irritate the cells of the tissues, these hypertrophy and proliferate thus drawing large quantities of fluid nourishment from the blood (attraction theory, nutritive stimuli). The humeral theory of inflammation accounts for the nature of inflammation in changed conditions of the blood (dyscrasia). According to the neural theory the nervous system plays the principal part in inflammation (paralytic and spasmodic theories of inflammation by Brücke, Stilling and others).

CAUSES OF INFLAMMATION.—The inflammatory stimuli that are operative on animal tissues are extremely variable in their nature. Mechanical, chemical, thermic and infectious causes may prepare the tissues for inflammation. In general inflammation according to causes may be divided into two, practical, very important groups. One group may be termed an aseptic or non-bacterial (non-infectious) inflammation; it is caused, not through the action of bacteria, but as a result of mechanical, thermic, and chemical influences (traumatic inflammation, burning, acrids). The other group includes the septic or bacterial (infectious) inflammations; they are due to the activity of micro-örganisms. The following are the most important causes of inflammation:

1. Mechanical irritants (wounds, pressure, contusions, strains, ruptures) produce the so-called traumatic inflammations: wound healing by first intention, healing of subcutaneous bone-fractures, muscle and tendon-ruptures, that form of inflammation of the pododerm known as laminitis, non-infectious inflammations of the joints (spavin, ringbone, chronic deforming gonitis, omarthritis and coxitis, chronic podotrochlitis), tendons, tendon-sheaths, mucous bursæ, and bones. A purely traumatic aseptic inflammation may combine with one that is bacterial and infectious in character (healing per secundam, healing of compound bone-fractures).

2. Thermic irritants in the form of heat and cold. Purely aseptic inflammations of this kind are burns (red-

ness, vesicles) and rheumatic inflammations, especially muscular rheumatism (non-bacterial inflammation of muscle due, simply, to irritation from cold). These thermic aseptic inflammations may afterwards combine with one that is infectious in character (suppurative infection of blisters).

3. Chemical irritants may produce various kinds and grades of inflammation without the aid of bacteria, especially suppurative inflammations. Experimental subcutaneous injections of sterilized chemicals (oil of turpentine, creolin, nitrate of silver, ammonia, and legumin) under aseptic precautions, produce an acute suppurative inflammation in the absence of bacteria (Grawitz, De Bary and others). Inflammation due to chemical irritants is of practical importance in therapeutics: through the application of irritants to the skin various grades of inflammation are produced for the object of healing (rubefacients, vesicants, pustulants, suppurants).

4. Infectious inflammations are caused by the entrance of microörganisms into the tissues. There are a great many kinds of bacteria that may cause bacterial or septic inflammations; namely, staphylococci, streptococci, edema bacillus, tubercle bacillus, glanders bacillus, anthrax bacillus, botryomyces and actinomyces. Examples of infectious inflammations are: suppuration of wounds, phlegmons, suppurative arthritis, tendovaginitis and pododermatitis. None of these organisms are mechanical irritants; inflammation is due to their chemical products of metabolism (toxins). Leber was the first to discover that infectious inflammation was due to chemical irritants. From a culture of staphylococcus he isolated a crystalline chemical substance (phlogosin) that has the property of inducing inflammation. The so-called parasitic inflammations (sarcosporidia) are of slight significance from a surgical standpoint; they also appear to be due to the action of chemical bodies (sarcozystin).

Finally, certain factors of the disposition have an influence in the production of inflammation (constitution, idiosyncrasy, immunity).

II. KINDS, SYMPTOMS, AND COURSE OF INFLAMMATION.

KINDS OF INFLAMMATION.—According to the character of the exudate various kinds of inflammation are recognized:

1. Serous inflammation is characterized by a serous, watery, lymph-like exudate containing very few white and red blood-corpuscles. It is the slightest grade of inflammation; the blood-vessels are only slightly changed. It occurs in the skin and subcutum (inflammatory edema, blisters, dermatitis bullosa); on the serous membranes of the joints, tendon-sheaths, and mucous bursae (serous arthritis, tendovaginitis and bursitis; hydrops of the joints, tendon-sheaths, and mucous bursæ); as well as on the mucous membranes (catarrhal inflammation).

2. Fibrinous or croupous inflammation is characterized by the formation of an exudate that is very rich in fibrin and white blood-corpuscles. As a result of this, croupous membranes (so-called fibrinous pseudo-membranes) are deposited on the inflamed tissues; leucocytes and fibrin threads make up the essential composition of these membranes. If a serous exudate is present at the same time it is termed a sero-fibrinous inflammation. Fibrinous inflammations most frequently occur on the serosa of the joints, tendon-sheaths, and mucous bursæ (arthritis, tendovaginitis, bursitis fibrinosa), on the mucous membranes (membranous conjunctivitis, as well as on the iris (fibrinous iritis of moon-blindness).

3. Suppurative inflammation is a special form which is usually due to an infection with pus-forming bacteria (streptococcus and staphylococcus pyogenes). The suppurative exudate is composed partly of emigrated white blood-corpuscles, partly of proliferated fixed connective-tissue cells. A circumscribed collection of pus in a tissue is termed an abscess. A diffuse suppurative inflammation is termed a suppurative infiltration; an accumulation of pus in joints, or in the cavities of the head, is termed empyema; suppurative inflammation of the mucous membranes, suppurative catarrh; of the mucuous membranes of the eye,

blennorrhea; the skin of the external auditory canal, otorrhea; purulent vesicles on the skin are termed pustules.

4. Diptheritic inflammation consists of a coagulation necrosis of the mucous membranes; that is, in a deposit of fibrin in the tissues with necrosis of the cells. It leads, either to the formation of a so-called diptheritic pseudomembrane, or to a loss of substance (diptheritic ulcers).

5. Hemorrhagic inflammation is characterized by the presence of large numbers of red blood-corpuscles in the exudate, which have left the vessels either per diapedesis of per rhexin. This form of inflammation always involves severe alterations in the walls of the blood-vessels.

6. Necrotic or gangrenous (ichorous, putrid) inflammation is characterized by a discolored exudate undergoing putrid degeneration (mixed infections with septic bacteria and putrefactive fungi.)

7. Productive or proliferative (hyperplastic) inflammation runs a chronic course, and results in new formations of tissue (thickenings, adhesions). According to the character of the new tissue it is termed indurated, schlerotic, ossifying, deforming, adhesive, pannous, fungous, verrucose, etc.

8. Specific inflammations correspond to specific infectious diseases (tuberculosis, glanders, actinomycosis, botryomycosis, strangles, anthrax). With reference to erysipelatous and phlegmonous inflammations see pages 28 and 46.

SYMPTOMS OF INFLAMMATION.—The cardinal symptoms of inflammation are: heat (calor), redness (rubor), swelling (tumor), and pain (dolor); disturbed function (functio laesa) may be added as a fifth symptom.

1. Increased heat is most pronounced in acute inflammations. In veterinary science it forms an important sign for the determination of the existence of inflammation, as the inflammatory redness is frequently invisible. Heat is due to an increased blood-flow, not to an increase in the production of local warmth in the inflamed tissue.

2. Inflammatory redness, in most animals, is usually

invisible in the skin on account of the hair and pigment in that tissue, on the mucous membranes, however, it is readily observed. Redness is due to the dilitation and pronounced fullness of the vessels (inflammatory hyperemia). One distinguishes between injection redness, where only individual vessels appear to be strongly injected, and diffuse inflammatory redness.

3. Swelling is the result of an increased blood-supply and an inflammatory transudate. According to the character of the exudate and the kind of tissue in which the disease is located, the consistence of the swelling on palpation is extremely variable: soft, firm, fluctuating, (abscess, hydrops of the joints and tendon-sheaths), or crepitating (fibrinous arthritis and tendovaginitis). Swelling is most pronounced in the widely reticulated tissue of the subcutis, in inflammation of the tendon-sheaths, joints, and glands.

4. Pain is due, partly to the pressure of the inflammatory swelling on the nerves, partly to the involvement of the nerves in the inflammatory process (neuritis). Acute inflammations of organs that are provided with a rich nerve-supply are extremely painful: skin, pododerm, periosteum, joints, eyes; chronic inflammations are usually less painful. Sudden relaxation of pain in an acute inflammation indicates a bad prognosis (necrosis of the pododerm).

5. Disturbed function is characterized by lameness, suspension of the glandular secretions, opacity of the cornea, etc. There is also a disturbance of the general condition; this is partly due to the pain, partly to the absorption of febrile producing irritants.

Course and Termination of Inflammation.—One recognizes an acute (existing for a few days), and a chronic course (longer duration, at least four weeks), occasionally a peracute (existing a few hours), and a subacute (existing for one or two weeks). With reference to the extent of inflammations, they are classified as superficial, and deep (parenchymatous, interstitial,) local or circumscribed, and diffuse or progressive. Finally we have inflammatory primary and secondary foci (metastatic, embolic, general-

ized, that is, an inflammation spread over the entire body through the medium of the blood-stream). The following are the most important terminations of inflammation:

1. The inflammatory product gradually disappears (resolution) as a result of the resorption of the inflammatory product through the lymph-stream under the influence of the white blood-corpuscles (phagocytosis, hystolysis).

2. The retention of inflammatory new formations in the form of thickenings, indurations, and adhesions (schlerosis, elephantiasis, tendon callus, exostosis, dermatitis verrucosa, etc.).

3. Gangrene may result from severe disturbances in the circulation or complications with septic infection.

With reference to inflammations of individual organs see chapters on inflammations of the bones, joints, muscles, tendons, nerves, vessels, glands, skin, etc.

III. TREATMENT OF INFLAMMATION.

THERAPEUTIC METHODS.—Those processes which take place in the tissues under the name of inflammation are considered necessary reactions of the body whereby external irritants are expelled, and the body again assumes its normal condition through the expulsion of these derangors of its function. Therefore, the inflammatory process, as such, should not be combatted. The essential problem of surgical therapeutics consists in the support of the body in its endeavors towards self-protection and natural adjustment, rather than in derangement of natural healing by means of improper treatment. Direct etiological methods of treatment are possible only in cases of septic inflammation (antiseptics). In all aseptic inflammations—those not due to bacteria—indirect, symptomatic therapeutics are the only ones to be considered. These consist in the application of rest, heat and cold, massage and cutaneous irritation.

REST.—Rest for the affected part is the fundamental treatment for nearly all painful inflammatory conditions.

Mere rest is all that is required for recovery from many inflammations. This is true of distorsions of the joints, aseptic inflammations of the hoof, and all chronic deforming inflammations of the joints (spavin, ringbone, gonitis, omarthritis). In any case, rest supports the action of other remedies. Motion is seldom indicated: chronic inflammation, for example, chronic muscular rheumatism. Rest, from a therapeutic standpoint, involves the removal of the cause of inflammation—the inflammatory irritant—the shoe or nail in inflammation of the pododerm; the saddle, harness, and check-rein in inflammatory conditions of the withers, saddle position, and jaw; irritating foreign bodies from beneath the lid in conjunctivitis; removal of loose pieces of necrosed cartilage and bone in chronic inflammatory processes (fistula of the lateral cartilage, bone-fistula).

HEAT.—Heat is indicated in all aseptic forms of inflammation, but especially for the subacute and chronic inflammations. Heat favors resorption of the inflammatory exudate. This is due to stimulation of the circulation, diffusion and migration of the phagocytes, as well as to softening and breaking down of the inflammed tissue. Heat also relieves pain by means of relaxation. Moist heat is especially useful in the form of frequently renewed Prieznitz bandages. The bandage is applied cold, this produces at first an active contraction of the vessels which is soon followed by pronounced dilitation. Frequent application of this bandage—every three to six hours—regulates the deranged circulation and has a favorable influence on the disturbed general condition (temperature, blood-pressure, activity of the heart, distribution of the blood, and nervous system). Warm poultices (cataplasms) exert a similar action; they are more difficult to apply to animals (antiseptic cataplasms in inflammation of the hoof). Recent methods of heat therapeutics in man are the hot-air treatment, the hot-engorgement (Bier), and the therapeutics of light (thermic action of red rays, chemical, bactericidal action of blue rays). A new heating apparatus with constant action has been invented by Ullman under the name hydro-thermo-

regulator; Bayer has recommended its use for the horse. The application of heat is contra-indicated in all septic inflammations, especially in septic phlegmons, as well as malignant edemas; it favors the extension of the process and the multiplication of the infectious material.

COLD.—This is indicated only in septic, as well as in the first stages of acute and very painful inflammations (tendon, joint, and hoof inflammations). Its action consists principally in a contraction of the dilated blood-vessels (anesthetic and hemostatic action); it also has an antiseptic action on the microörganisms that cause inflammation. Cold retards the motility of white blood-corpuscles and even stops their migration. The application of cold according to a set of fixed rules is more harmful than useful in aseptic inflammations, because the natural healing process of phagocytic reaction is destroyed.

According to experiments made by Bayer with employed methods of application of cold, the most pronounced action resulted from permanent irrigation of a shaved area with cold flowing water (water tubes); at the end of one hour the temperature had fallen 20°. A spray of ether reduced the temperature fifteen degrees in ten minutes; fifteen minutes after the spray had been removed the temperature had returned to normal. Seven to eight degrees was the maximum reduction of temperature from the application of ice bags and Leiter's tubes. The action of cold baths and cold bandages is very weak; when changed every five minutes the temperature dropped 3 to 5 degrees in favorable cases; ordinarily the temperature drops only during the first two or three minutes and then rises again. Cold baths must be frequently renewed, or cold may be applied in the form of a stream. Applications of clay, which were extensively used at one time are entirely insufficient; like cold baths the temperature is slightly reduced after a few minutes, but soon returns nearly to normal. The fol-

lowing is an experimental case : the subcutaneous temperature was 35.7° C., a clay pack of 12.5° C. was applied, the temperature sank in five minutes to 32.5° C. In thirty minutes it returned to 34.5° C., and after sixty minutes to 34.9° C.

MASSAGE.—Massage is a very important form of treatment in subcutaneous, and chronic aseptic inflammation of tendons, joints, muscles, bone, and skin. It is contra-indicated in septic, infectious, suppurative inflammations, especially phlegmons, as it favors the spreading of the disease process. It is also contra-indicated in painful acute inflammations. Four kinds of massage are recognized :

1. Stroking (effleurage).
2. Rubbing (friction).
3. Kneading or malaxation (petrissage).
4. Tapping (percussion).

Constant pressure (compression) may also be considered a form of massage. The action of massage consists in the removal of the exudate from the diseased and inflamed tissue ; it is mechanically forced into the lymph channels and thus prepared for resorption. The distension and swelling of the inflammatory enlargement are overcome, thus reducing the pain. The circulation, nourishment, and innervation are stimulated.

CUTANEOUS IRRITANTS.—The so-called counter-irritant method is of great importance in veterinary science in the treatment of chronic inflammations. Blisters and firing are the most important cutaneous irritants. These are especially useful in chronic inflammations of the tendons and joints, where the results are very satisfactory. Their action is due to the transformation of a chronic to an acute inflammation, which makes possible the resorption of the inflammatory product. The cutaneous irritants mentioned produce the following changes in tissues affected with chronic inflammation : dilitation of the blood-vessels ; inflammatory transudation of the blood-serum ; migration of the white blood-corpuscles (phagocytosis) ; formation of ferments (enzymes) out of the white blood-corpuscles,

by which the albumenous bodies in the chronically inflamed tissue are digested in the form of albumenoses (propeptones), and the solid products are softened, thus passing into solution (histolysis). An actual cutaneous irritant exerts a deep influence on tendons, bones, and joints. This has been demonstrated by microscopic examination of tissues following the application of tincture of iodine to the skin. A few hours after the application there occurs an extensive transudation, and emigration of the white blood-corpuscles into the skin and subcutem, as well as into the intermuscular tissue and periosteum of the underlying bones. These acute inflammations may even reach to the bone-marrow and lead to loosening and solution of the cartilage at the epiphyses (Volkman).

AGENTS THAT OPPOSE INFLAMMATION.—As many inflammations are of an infectious nature they may be effectually combated with antiseptics. In the treatment of deep inflammations (phlegmon, strangles, tendinitis) antiseptics which penetrate the skin must be employed (camphor, carbolic acid, tar, iodoform, mercury, etc.). Other drugs which find use are the metallic and vegetable astringents; they constrict the blood-vessels, form a protective dry covering, and at the same time disinfect (silver nitrate, sugar of lead, acetate of lead, alum, sulphate of zinc, lime water, tannin, and tannoform). The so-called protective materials have a purely mechanical action (oils, salves, collodion, plaster). Potassium iodide is a specific for antinomycosis.

The serum treatment for inflammation and wound infection diseases (antistreptococcic serum) has not proved satisfactory.

OPERATIVE TREATMENT OF INFLAMMATION.—In many forms of inflammation, especially the infectious (abscess, phlegmon, ichorous inflammation), incision with subsequent irrigation and drainage is preferable to any other treatment. Against chronic hygromata (capped-hock) injections of pure cultures of staphylococcus pyogenes have been employed; this results in the formation of an acute abscess which is treated as such (?). In gangrenous inflammation the necrotic portions must be removed, it may be necessary to

amputate (tail, teeth, udder, ear, wings, limbs of dogs). Other operations are scarification, that is, the local drawing of blood by means of incisions or punctures; phlebotomy, at the present time this is employed surgically only in that form of acute, aseptic inflammation of the pododerm known as laminitis. Periosteotomy (artificial acceleration of anchylosis formation by means of spavin operation) was frequently employed at one time for spavin, and chronic periostitis on the metacarpus.

ULCER, FISTULA, GANGRENE.

I. ULCER, ULCERATION.

DEFINITION.—From a surgical standpoint an ulcer may be defined as a wound that has no tendency to heal (Billroth). It may also be termed a chronic, suppurative inflammation with a tendency to degeneration of the tissues; as a continual suppurative degeneration of the granulations of the wound. Ulcerative degenerations also exist in tumors as a result of suppurative infection of the new growths (carcinoma). From a standpoint of pathological anatomy an ulcer may be defined as a tissue defect due to necrosis or suppuration.

CAUSES.—The causes of ulcers are partly local, partly general. Two main groups of ulcers are recognized:

1. A primary and idiopathic ulcer is due to the influence of a continuous inflammatory irritant on the wound. It may be due to shaking the ears after injuries, constant licking of the wound at the point of the tail or on the limbs in dogs. Other causes are irritation due to the presence of foreign bodies in wounds, retained masses of pus, pieces of necrosed bone, cartilage and teeth, continued irritating influence of carious teeth on the neighboring gums.

2. A secondary or symptomatic ulcer is the result of a complication with a suppurative inflammation. To this form belong cancerous ulcers; those of glanders, tuberculosis and actinomycosis; the corneal

ulcers of dog distemper and diabetis mellitus; and the genital ulcers of dourine.

The so-called varicose ulcers of man, which occur on the tibia, do not exist in the lower animals; they are due to an inflammatory vascular engorgement induced by a dilitation of the veins of the skin, and are very common. On the other hand, the so-called trophoneurotic ulcers, which develop in man after severe neural disturbances, are also seen in the lower animals (corneal ulcers following paralysis of the trigeminus).

FORMS OF ULCERS.—According to the character of the granulations ulcers are termed indolent (atonic, torpid, painless), and irritable (erethistic, inflammatory, painful). According to the character of the margins ulcers are termed smooth and callus, that is, they have wall-like, firm, cicatricial margins. With reference to the depth they may be superficial, deep, or sinuous (sinuate, undermined), or tube-shaped and fistulous (fistula). Superficial ulcers on the mucous membranes are termed catarrhal or erosion ulcers. According to the character of the surface of the ulcer it is termed hemorrhagic, ichorous, gangrenous, necrotic, diphtheritic, fungoid, (hypertrophic, luxuriative), and phagadenic (cancerous, increasing rapidly in diameter). Serpiginous ulcers (creeping) are those which move from place to place, healing in one place and extending in another. The following classification is made with reference to the size: miliary (size of a millet seed), lenticular (size of the crystalline lens), those the size of peppers, peas, dollars, etc. With reference to the form, ulcers may be round, oval, or irregular.

TREATMENT.—Many ulcers heal simply as a result of rest, that is, after the removal of the irritating cause. Ulcers at the ends of dogs ears, for example, heal after the application of a bandage or ear-cap which prevents the shaking of their ears. The same is true of ulcers at the point of the tail, on the extremities, and on the eyes (cocaine).

Other methods of treatment are extirpation, cur-

rettage, firing, or cauterization; they are thus transformed into fresh wounds. The application of such agents as the knife, curet, cautery, chloride of zinc, sublimate, chromic acid, and other caustics is preferable to the use of weaker antiseptics and irritants.

Iodid of potash is an internal specific for actinomycotic erosion ulcers of the oral mucous membranes; necrotic ulcers due to a general diseased condition may be treated with arsenic. Ulcers of glanders are not treated.

THE MOST IMPORTANT ULCERS IN DOMESTIC ANIMALS.—Ulcers of surgical importance are far less common in animals than in man. The following are of practical importance:

1. Ulcers at the point of the ear in dogs.
2. Ulcers at the point of the tail in dogs and cattle.
3. Corneal ulcers in dogs affected with distemper.
4. Hoof ulcers in horses (sole or wall).
5. Decubital ulcers as a result of lying.
6. Stomatitis ulcers in dogs.
7. Cancerous ulcers with carcinoma of the skin in horses and dogs.
8. Ulcers of the tongue and lips in horses and cattle.

Also, many badly granulating wounds, as well as many treads on the coronet, and pressure injuries in the region of the saddle, on the withers and on the neck of the horse, may be considered as ulcers.

II. FISTULA.

DEFINITION.—In surgery many diseases are recognized under the term fistula. One must differentiate between two different processes.

1. Pus fistulae may be regarded as tube-like or sinuous ulcers; they result from inflammatory suppurative foci that form in the depths of the skin, subcutem, muscles, bone, cartilage, and glands, and which reach the surface by a process of gradual ulceration (Billroth). They are, therefore, the product of a chronic, suppurative, destructive inflammation in the depths of the tissues. The inflammation is frequently sustained by the presence of fragments of necrosed tissue (cartilage, bone), occasionally it is supported by the pres-

ence of specific microorganisms (botryomyces); the suppurative exudate being discharged through a tube-shaped canal. The following are examples of fistulae; fistula of the lateral cartilage, fistula of the spermatic cord, tooth fistula, fistulous withers, poll-evil, phlebotomy fistula, fistula of the fetlock, coronary fistula, gluteal fistula, sternal fistula, pelvic fistula, costal fistula, and other bone fistulae.

2. Secretion and excretion fistulae imply a pathological relation of deeply seated secretory organs (glands) and excretory organs (stomach, intestines, bladder) with the external surface of the body. To this class belong salivary fistulae, lachrymal fistulae, milk fistulae, gastric fistulae, intestinal fistulae, ear fistulae, and fistulae of the uterus. They are due, either to traumata, and inflammations (acquired fistulae), or they may have a congenital origin (ear fistula, fistula of the intestines, urinary fistula). When the canal has a free communication with the excretory organ and the external surface it is termed a complete or communicating fistula, when the canal ends in the tissues it is termed a blind fistula. According to the form of the fistulous tract it is termed a canal, funnel, or lip-shaped fistula. Other forms are skin, mucous membrane, corneal, serous, and tendon-sheath fistulae.

PUS FISTULAE.—The symtoms of pus fistulae are variable according to their location. The fistulous opening is about the same in all forms; it is usually small, constricted, indurated, pus in various quantities is discharged from it. The walls of the canal may be hard or smooth; occasionally it is filled with torpid granulations. At the bottom of the canal one can usually feel a rough, hard mass of tissue (necrosed piece of cartilage or bone). Fistulae are usually painless, as they are the product of a chronic inflammation. They may, however, become complicated with an acute inflammation—an acute phlegmon for example—under the influence of an injury or an improper operation.

The treatment of pus fistulae is analagous to that of ulcers. The suppurative ulcerative, and badly granulating walls of the smooth, indurated and encapsuled fistulous tract are transformed into clean wound surfaces. One should be particular to remove the necrosed tissue at the fistulous canal. An operation, therefore, is the best treatment for a pus fistula ; open freely to the bottom, remove the necrosed tissues (cartilage, bone, teeth), extirpate the indurated walls and remove the granulations. For this purpose one may use the scalpel, scissors, curet, bone-forceps, chisel, etc. To merely split the fistula or cut around it, is usually insufficient. After splitting, the essential treatment is unperformed : this consists in the removal of the chronically inflamed fistulous walls, and the ulcerative surfaces at the bottom. When operating a pus fistula strict antisepsis is necessary to prevent infection of the fresh wound surface from the old suppurative foci. When these principles—upon which Bayer placed special emphasis—are not observed, or when splitting of the fistula is not followed by careful removal of the necrotic, pus-infiltrated tissue ; the operation is easily followed by an acute suppurative infection of the previously healthy tissue, an extensive phlegmon is especially liable to occur. One should observe the converse precaution : that, frequently, the operative removal of a fistula appears to be contra-indicated as long as there is an acute phlegmonous inflammation in its vicinity. In such cases the operation must be deferred until the phlegmon has subsided. Möller placed special emphasis on this surgical principal in the operative treatment of fistula of the lateral cartilage, it is necessary to coincide with his view on this subject.

When a fistula cannot, or should not, receive operative treatment it may be fired or cauterized, an operation is more rapid and effectual. The mere application of antiseptics is seldom effective.

SECRETION AND EXCRETION FISTULAE.—These are readily distinguished from pus fistulae by the fact that, instead

of pus, various secretions and excretions are discharged from the opening ; saliva, milk, urine, food, gastric contents, intestinal contents and feces. Their healing is much more difficult than that of pus fistulae. The conditions which produce an unfavorable prognosis are : continual pressure from the discharging glandular secretions, operations on the stomach and intestines (gastric fistula, intestinal fistula) lead to an opening of the abdominal cavity, when a fistulous process exists this is doubly dangerous. Operations intended to bring about removal of secretion and excretion fistulae are of a plastic nature, they consist in an artificial scarification and suturing of the fistulous openings. Firing and caustics are seldom effective. In many cases radical treatment is the only method of healing secretion fistulae, such as extirpation of the secretory gland (extirpation of the parotid in the horse).

THE MOST IMPORTANT PUS FISTULAE IN DOMESTIC ANIMALS.—The following are of practical importance :

1. Fistula of the lateral cartilage in the horse. This is a circumscribed necrosis of the cartilage which usually develops from a parachondral phlegmon and induces a chronic ulcerative condition with one or more fistulous canals leading to the coronet. Treatment : Extirpation of the lateral cartilage (Bayer's method).

2. Fistula of the spermatic cord in the horse is due to a chronic, suppurative, indurative inflammation of the spermatic cord (funiculitis chronica) and the tunica vaginalis. It is caused partly by the botryomyces fungus (botryomyces of the spermatic cord), partly by ordinary pus cocci. Treatment : Extirpation of the degenerated spermatic cord (ligature, emasculator, ecraseur).

3. Tooth fistulae occur in horses, especially on the premolars of the inferior maxillae ; in dogs they are more frequently seen on the upper jaw. They are the result of a suppurative alveolar periostitis, ostitis, and osteomyelitis. Treatment : Extract the tooth.

4. Bone fistulae develop from a suppurative, especially necrotic, periostitis, ostitis, and osteomyelitis. According to their seat they are classified as follows : sternal fistula, pelvic fistula, costal fistula, inferior maxillary fistula (false tooth fistula), fistula of the tail, fistulae of the round bones, etc. Treatment : Removal of the necrotic piece of bone (sequester) by means of chiseling, trepanation, curettage, and firing. Because of the deep seated position of the bone sternal fistulae heal with great difficulty.

5. Fistulous withers and poll-evil exist in the horse as

a result of contusions; the contusions are followed by phlegmon and necrosis of the skin, subcutem, bursae, fasciae, muscles, and bones, on the withers, in the saddle position, and in the region of the neck. Treatment: Operative removal of all necrotic portions, antiseptic drainage and irrigation.

6. Phlebotomy fistulae are supported by a suppurative thromboplebititis of the jugular vein. Treatment: Double ligation and extirpation of the diseased vein.

THE MOST IMPORTANT SECRETION AND EXCRETION FISTULAE.—The following are of practical importance:

1. Milk fistulae in cows are due to injuries, followed by inflammation of the udder and abscess formation; they usually occur during lactation; occasionally they are congenital. One distinguishes between a fistula of the gland and one that leads to the milk duct. Treatment: Scarification and suturing, firing, cauterization, application of a milk catheter, healing is often possible only during the dry period.

2. A salivary fistula is due, either to an injury from without (wounds), or within (salivary calculi), it may be either a fistula of the gland or duct. Treatment: Ligation, scarification and suturing, firing, extirpation of the gland, injection of caustics.

3. Ear fistula (cervical fistula, cervico-branchial fistula) in the horse is a congenital branchial-cleft teratoma at the base of the ear, which contains a tooth (tooth-follicle cyst, erratic tooth). Compare with the chapter on teratomata. Treatment: Extirpation.

4. Pharyngeal and esophageal fistulae are due to external and internal injuries, as well as to perforating abscesses. Treatment: Suture.

5. Gastric and intestinal fistulae are the result of external and internal penetrating wounds. According to the seat, and species of animal they are classified as follows: Fistula of the abomasum, rumen, reticulum, small intestine, large intestine, and rectum. A very large intestinal fistula is termed anus praeternaturalis—artificial anus—; vagino-rectal fistula is termed cloaca (anus vaginalis, recto-vaginal fistula); a fistula uniting the bladder and rectum is called an anus vesicalis. Treatment: Plastic operation.

6. Cystic and urethral fistulae are both termed urinary fistulae. They are acquired (traumatic) or congenital. The following are special forms: vesico-vaginal, vesico-rectal, and vesico-intestinal. In a fistula of the urachus (dropping of urine from the navel) the urine discharges continually from the urachus because the fundus of the bladder is not closed.

Other forms of fistulae are lachrymal fistulae, corneal fistulae, fistulae between the oral and nasal cavities.

III. GANGRENE. NECROSIS.

DEFINITION AND KINDS.—The term gangrene (necrosis, mortification) indicates death of groups of tissues, as well as local tissue death. In surgery various kinds of gangrene are recognized, in especial, dry gangrene (gangraena sicca) or mummification, and moist gangrene (gangraena humida) or maceration (liquefactive degeneration). When accompanied by symptoms of inflammation it is termed hot, otherwise, cold gangrene (sphacellus). The colonization of putrefactive organisms (saprophytes) on moist gangrene results in putrid gangrene (putresence). Ichorous or phagedenic (phagedena) gangrene is termed putrid, progressive gangrene. Gas gangrene (gangrenous emphysema) is caused by a mixed infection with gas-producing bacteria (bacillus phlegmonae emphysematosae, gas-generating varieties of bacterium coli). A circumscribed bone necrosis is termed a sequester; certain liquefactive processes on the bones and teeth are termed caries. Gangrene of the mucous membrane is termed diphtheria. Superficial, dry, gangrenous areas are termed eschars. So-called coagulation necrosis is a special anatomical form of gangrene.

One further differentiates: gangrene of the skin, pododerm, subcutem, bone, muscles, tendons, mummification and maceration of the fetus, a circumscribed and progressive, an infectious and non-infectious (septic and aseptic) gangrene.

CAUSES OF GANGRENE.—1. Mechanical interruption of the circulation is one of the most frequent causes of gangrene. Uninterrupted compression, or that which is combined with destruction of the tissues (pressure, contusions, strangulations, incarcerations) causes gangrenous death as a result of anaemia, especially when combined with injuries to blood-vessels (pressure necrosis, decubitis). The statement has already been made under contusions, that mechanical destruction, alone, does not result in cellular death. Ligatures, thrombus formations, emboli, as well as diseases of the walls of arterial vessels produce results similar to those of

compression; they cause an interruption in the exit of the venous blood (anaemic necrosis). Death of the skin and muscle occurs in from ten to twelve hours after the circulation has been stopped; anaemic necrosis of the intestines follows complete interruption of one or two hours (incarcerated hernia). Bone and cartilage are the least sensitive. Derangement of the circulation due to hyaline thrombosis of the branches of the peripheral arteries may result from gangrene (mummification of the extremities) due to ergot-poisoning (ergotism).

2. Chemical causes of necrosis include the caustics. Their action is variable. The metallic caustics (sublimate, chloride of zinc, chromic acid, sulphate of copper) destroy the tissue cells through the formation of a precipitate of metallic albumenates, and freeing of the acid compounds. The caustic acids (nitric acid) produce an eschar formation through the coagulation of albumen; they also destroy cells by absorption of water (sulphuric acid). The alkalies (caustic potash, lime, ammonia) transform the albumen of the tissues into a slimey, pulpy mass (alkali albumenate). Formaldehyde produces a dry, horn-like, very deep necrosed area. Snake poisons, as well as many infectious materials, may produce necrosis by their chemical action.

3. The following thermic influences are classified as causes of necrosis: high degree of heat (burning, combustion), and cold (freezing, frost-gangrene, congelation). The so-called third grade of burning and freezing is nothing but necrosis. There is a great difference in the susceptibility of different tissues to thermal influences, a loop of intestine, for example, dies in a few hours when exposed to an increased temperature of 8° C.

4. Many infectious irritants cause so-called gangrenous inflammations. Death of the tissues is due partly to the chemical action of bacterial toxins, partly to their derangement of the circulation. The ordinary pus-forming bacteria—streptococci and staphylococci—have the ability during the course of a suppurative inflammation, namely, phlegmon, to produce necrosis (necrosis of the

lateral cartilage during the course of a parachondral phlegmon). The necrotic action of the following septic bacteria is especially strong: necrosis bacillus, anthrax bacillus, blackleg bacillus, edema bacillus, glanders bacillus, the bacteria of hog cholera, swine plague, and swine erysipelas (necrosis of the skin in swine), malignant foot rot, gangrenous eczema, gangrenous pox, the so-called gangrenous erysipelas of sheep and swine, infectious diseases that are characterized by diptheria of the mucous membranes, as well as many cases of petechial fever in the horse (necrosis of the skin, mucous membranes, the nasal septum, the prepuce, and even the articular cartilage.)

Also many fungi (necrosis fungi), especially tilletia caries, ustilago carbo, ustilago maidis, and polydesmus exitiosus, produce necrosis on the skin and mucous membranes of cattle, horses, and sheep. The buds of buckwheat seem to produce gangrene in a similar manner (fagopyrismus), the same is true of lupinosis in horses, and clover-disease, as well as the so-called gangrene of white spots. Necrosis of the skin and mucous membranes has been observed in the horses of Batavia as a result of the colonization of a mould (hyphomycosis destruens equi).

5. Frequently several causes are operative at the same time. Pressure necrosis in horses and cattle may follow relatively slight mechanical insults when a severe general disease exists at the same time. This is especially true of diseases of the circulatory apparatus (fever, septicemia, diseases of the blood, anaemia, cachexia, cardiac diseases, general exhaustion). The following types of gangrene present similar conditions: gangrene of old age (gangraena senilis), the so-called sugar gangrene (gangraena diabetica), and that which follows diseases of the spinal marrow, so-called symmetrical gangrene.

NECROSIS BACILLUS.—Under this name Bang described a bacillus that had already been observed by Löffler and Schmorl; it occurs in a great number of disease processes, partly as a cause, partly as a concurrent symptom (mixed infection). It is an ubiquitous bacterium,

especially in the intestinal contents, the feces, in dust and dirt; in the tissues it causes coagulation necrosis, and diphtheritic, ulcerative degenerations. It belongs to the filiform bacteria ("streptothrix necrophora"), and develops, partly in the form of rods, partly as a coccus, and partly in the form of long filaments—as long as 100 microns; on staining it presents clear, round or cylindrical spaces. It is an anaerobe, non-motile, and without flagellae (Ernst). With Loefflers solution of methyeline blue or carbol-methyeline blue, recognition is easy; it is decolorized by Gram's method. It grows best in coagulated serum as well as in semi-solid media at 39° C. House mice are specially sensitive to inoculation; after subcutaneous injection there develops an extensive necrosis of the tissues, which results in death in the course of a week. The following conditions are caused by subcutaneous injections into the ear of a rabbit; extensive necrosis with thrombus formation in the large veins, embolic foci in the lungs, secondary pleuritis, occasionally necrosis in the heart and other organs. Injections in cattle, sheep, and swine result only in local swelling and abscess formation (Ernst). Bang and Jensen have found the necrosis bacillus in the following places:

1. In the HORSE as a cause of gangrenous dermatitis (grease), fistulae of the lateral cartilage, coronary fistulae, and in diptheria of the mucous membrane of the colon.

2. In CATTLE as a cause of panaritium, gangrenous pox, diphtheria of the uterus and vagina (also demonstrated by Ellinger), in necrotic inflammation of granulating wounds, in calf diptheria, in necrosis nodosa multiplex of the liver, abscesses of the liver, and embolic necrosis of the lungs and heart.

3. In SWINE in necrosis of the skin, diphtheria of the nasal mucous membranes and oral mucous membranes, as well as in necrotic foci of intestines and lungs in swine plague.

4. In RABBITS Schmorl has observed a contagious, progressive, necrotic inflammation caused by the necrosis bacillus. It was ushered in with pronounced swelling of the head (under lip) which extended to the neck, thorax, and abdomen, and terminated fatally in from 12 to 16 days.

SYMPTOMS.—Dry gangrene is characterized by dryness of the dead tissues. The necrotic skin appears to be covered with dried secretions, it is scabby, leathery, parchment-like, sometimes as hard as horn, from brown to black in color, cool and non-sensitive. Dry gangrene is most often seen in the following places: on the back from saddle pressure, decubital

gangrene on the external angles of the ilium, zygomaticus, etc., at the point of the tail in dogs, on the claws of cattle, on the cornea, following cauterization with nitric acid and formaldehyde, after death and drying of the fetus in the uterus (mummification).

Moist gangrene presents the following symptoms: the necrosed tissue has the appearance of a slimey, soft, slushy, pulpy or ichorous, bloody mass; in color it may be grayish-yellow, grayish-brown, dark-yellow, dark-brown, brownish-green, grayish-green, violet, or black. A necrotic lateral cartilage is of a beautiful light-green color (bacteria which form coloring matter). The necrotic masses of tissue are usually cool and non-sensitive (cold gangrene). When inflammation exists at the same time they have a warm sensation (hot gangrene). Stinking, putrid gases occasionally develop in the dead tissues (sulphide of hydrogen, hydrocarbons, hydrogen, ammonia, carbonic acid), they cover the external skin in the form of blisters, or produce a frothy condition of the ichorous mass (gangrenous vesicles, gangrenous emphysema, emphysema septicum).

The gangrenous dead part is separated from the sound tissue through a reactive, suppurative inflammation under the formation of granulation tissue (demarking inflammation, line of demarcation, zone of necrosis). When the gangrenous process extends to the walls of the large vessels it may result in a gangrenous erosion of the vessel-wall and lead to severe arterial and venous hemorrhage. The general condition is also frequently affected (septic and pyemic affection).

Moist gangrene is most often found during the course of septic phlegmons, on the pododerm, coronet, flexor surface of the fetlock (gangrenous eczema), in the saddle, withers and neck region, on the lower parts of the extremities, on the inferior margin of the lower jaw and tongue in the horse; on the udder of the cow, sheep and goat, on the scrotum and tail of cattle and dogs, as well as on the fetal membranes (putrid degeneration following retention), and in the fetus (putrid emphysematous and macerated fetus).

TREATMENT.—Treatment of necrosis consists in operative removal of the necrosed part (knife, scissors, curet, forceps, chisel, trephine, etc); occasionally amputation of an entire organ of the body is necessary (tail, end of the tongue, penis, udder, claws, ears, limbs of dogs). Sloughing of the dry gangrenous masses may follow the application of antiseptic cataplasms. Above all, thorough and continuous disinfection is necessary. To prevent decubitis in horses and cattle use plenty of soft bedding (tan-bark, sand).

ATROPHY.—Atrophy is a reduction in the size of organs, as well as individual cellular elements; it is due to deranged nutrition and pathological retrogression. (Aplasia is complete failure of organs, the testicles, for example). From an etiological standpoint the following kinds of atrophy are recognized in surgery:

1. Atrophy of inactivity is the result of inactivity of organs, especially the muscles and glands. The cells, because of inactivity, cease to assimilate (active atrophy). Compare with chronic lameness in the horse that is usually accompanied by active muscular atrophy, as well as atrophy of the penis in phimosis (high urinator).

2. Pressure atrophy is the result of continued compression of organs, for example, from new formations (passive atrophy). This is seen on the os pedis as a result of keratoma.

3. Degenerative atrophy is due to deranged nutrition accompanying the course of an inflammatory process, for example, in the udder and eye (atrophy and phthisis bulbi in moon blindness and suppurative panophthalmia); in muscular inflammation of the quadriceps, anconeus, and longissimus dorsi (inflammatory atrophy); it may also follow paralysis of the nerves, for example, the suprascapularis (muscles on the external surface of the scapula), the trigeminus (muscles of mastication), the spinal marrow (posterior limbs) (neurotic atrophy). This is not usually a form of simple atrophy; degenerative changes usually occur. Other forms are senile atrophy, the so-called lipomatous atrophy of the muscles (obesity), and the udder (fleshy udder). For further data concerning atrophy compare with the chapter on diseases of the muscles and bones.

ATRESIA. OBLITERATION.—These terms indicate the closure or growing together (adhesion) of body openings and canals.

1. Atresia is a congentital malformation. It occurs in animals in the following places: rectum (atresia ani), on the eye lids (atresia palpebrarum), in the milk canal and milk cystern, as well as in the lachrymal duct.

2. Obliteration is an acquired cicatricial adhesion; it results from wounds and inflammatory processes

in the vagina, on the vulva on the sphincter of the teat, in the commissure of the lids, as well as in the vessels in thrombus formation, which terminate in a form of cicatrization. In the female genital canal there occasionally occur adhesions in the vulva and vagina after injuries during coitus and parturition. Adhesions at the mouth of the teat and in the milk cystern with the formation of folds in the walls are more common; they are caused by injuries, eczema, contagious aphtha, and catarrhal mastitis. Treatment of atresia and cicatricial adhesions is operative (perforation, teat probe, milking tube, bougies).

STENOSIS.—Stenosis is a narrowing of the canals and cavities of the body, especially the following: esophagus, trachea, urethra, vagina, intestines, milk ducts, salivary ducts, nasal cavities, maxillary sinuses, the frontal sinuses, and intestines. According to the cause the following forms of stenosis are recognized:

1. Compression stenosis. This is due to pressure of new formations or abscesses from without on neighboring canals; for example, the trachea (goitre); on the esophagus (tuberculous new formations in its vicinity); on the rectum (paraproctal abscesses and new formations, tumors of the prostate).

2. Obturation stenosis consists of a narrowing or stenosis of the canal from within through foreign bodies or new formations. Examples of this are: obliteration of the esophagus from the retention of food (pieces of turnips or potatoes); obstruction of the urethra by calculi; of the salivary duct by salivary calculi; of the intestines by intestinal calculi; narrowing of the lumen of the trachea after fracture of its cartilage (infraction); stenosis of the teat canal in cattle from wart-like new formations, connective tissue, and epithelium, frequent ring-like growths of the mucous membrane (so-called hard milkers); stenosis of the lachrymal duct as a result of catarrhal swelling of the mucous membrane; stenosis of the nasal, frontal, and maxillary cavities by new formations by which they are occasionally entirely filled; stenosis of the external auditory canal in dogs by papillomata.

3. Cicatricial stenosis or stricture is due to a cicatricial retraction following a previous injury or inflammation. It is seen in the trachea after tracheotomy, in the esophagus after esophagotomy, in the urethra after urethrotomy, in the vagina following injuries due to coitus and parturition, in the teat canal as a result of wounds and chronic inflammation (chronic mastitis), in the false nostrils following injuries with a severe loss of substance.

4. Congenital stenosis is seen, especially in cattle, in the teat canal and at the passage from the milk cystern to the teat canal; occasionally all four teat canals are abnormally narrow (hard milkers). In cows one also occasionally finds congenital stenosis of the vagina (dystocia). A similar condition is observed in the lachrymal duct of the horse.

Spasmodic stenosis is very uncommon (spasmodic contraction of the esophagus).

ECTASIA. DILITATION.—These terms indicate an enlargement of canals and body-cavities; the condition is exactly opposite to that produced by stenosis. According to the anatomical form the following varieties are recognized: diffuse and circumscribed (diverticulum), cylindrical, spindle-shaped, and sac-like. There is also a genuine and a false ectasia. From an etiological standpoint the following are recognized:

1. Pulsion-diverticulum formed by outward pressure from an object within the canal: food above a stenosis of the esophagus retained urine from a stenosis of the urethra. Here also belong dilitations of the cavities of the head in hydrops.

2. Traction-diverticulum is due to a retracting cicatrix from without. To this class belong macrostomia as a result of extensive injuries to the angles of the mouth.

TUMORS.

I. GENERAL CONSIDERATIONS.

DEFINITION.—From a surgical standpoint, in a restricted sense, one usually understands a tumor to be an atypical new formation not the result of inflammation; it has no assignable cause nor physiological termination; it has no anatomical type, that is, it varies from the type of tissue from which it develops (Cohnheim, Lücke). This definition does not include the inflammatory new formations of tissue (hyperplasia), or the so-called infectious granulation tumors (tuberculosis, actinomycosis, botryomycosis, glanders). A complete understanding of the nature of tumors has not yet been acquired.

CLASSIFICATION.—From a clinical standpoint one first differentiates between malignant and non-malignant tumors. Carcinoma and sarcoma belong to the malignant type. They are malignant for the following reasons: they develop rapidly with a destruction of the neighboring tissues, they have a tendency towards ulcerative degenerations, and they are especially distinguished for the formation of metastases in distant organs. The metastatic formations are pro-

duced in the following manner: small portions of the tumor (cancer cells) first enter the lymph-channels (local lymph gland metastasis) and from there find their way into the blood-stream (general metastasis of the lungs, liver, and other internal organs). Occasionally the cancer cells enter directly into the veins that are located in the tumor (jugular) and thereby gain entrance to the blood-stream. Aside from metastasis, malignant tumors may spread by continuity, contiguity, and dissemination (proximity, contact, becoming detached and forming new colonies).

The histological classification of tumors depends upon their microscopic condition. Tumors are composed of cells, connective tissue, and blood-vessels. Various groups and varieties have been formed with reference to the cells which go to make up the principal parts of the tumor. Following this classification according to Waldeyer they fall into two large groups:

1. CONNECTIVE-TISSUE TUMORS, (desmoid growths of Waldeyer, histoid growths of Virchow). They are composed principally of cells from the middle germ layer. They may possess the structure of connective tissue (fibroma, sarcoma), of fatty tissue (lipoma), mucous tissue (myxoma), cartilage (enchondroma), bone (osteoma), muscles (myoma), the vessels (angioma), or the nerves (neuroma). Frequently these tumors have no typical structure, but are a mixture of various types, so-called mixed tumors.

2. EPITHELIAL TUMORS, (epithelial growths of Waldeyer, organoid tumors according to Virchow). They are composed principally of epithelial cells from the inner or outer germ layer. Carcinomata and adenomata are the principal representatives of this group.

HISTOLOGICAL CLASSIFICATION OF TUMORS.—Virchow divided the tumors in general into extravasation or exudation tumors (hematoma, hygroma), retention tumors (mucous cysts, atheromata) and proliferative tumors, or tumors in the narrow sense. The tumors, in the narrow sense, regardless of whether they contained one or several varieties of cells, were classified by him as follows: (a)

HISTOID tumors: fibroma, lipoma, enchondroma, osteoma, myxoma, myoma, neuroma, angioma, sarcoma; (b) ORGANOID tumors: carcinoma; (c) TERATOID tumors: dermoid cysts.

Cohnheim, with whom Tillman and others coincide, distinguished: (a) tumors formed according to the type of connective-tissue substance (desmoid tumors according to Waldeyer): fibroma, lipoma, myxoma, chondroma, osteoma, angioma, lymphangioma, endothelioma, lymphoma, sarcoma, and mixed tumors of the types named; (b) tumors of the type of muscle tissue (myoma); (c) tumors of the type of nerve tissue (neuroma, glioma); (d) tumors of the type of epithelial tissue (epithelial growths according to Waldeyer): carcinoma, adenoma, cystoma, epithelioma, onychoma, teratoma.

CAUSES.—Nothing definite is known concerning the origin of tumors. Among the numerous theories of tumors the following are worthy of mention.

1. According to the EMBRYONIC THEORY of Cohnheim the existence of tumors, especially cancer, may be referred to proliferation of embryonic tissues; there is an excessive formation of this tissue during fetal development, or an aberration of its physiological coherence whereby it is changed into other tissue. These embryonic cells remain undeveloped in most individuals; in others growth may be stimulated as a result of injuries, mechanical or chemical irritants, hyperemia, or inflammation. The inheritance of many tumors, as well as the existence of desmoid cysts in the inner organs (misplaced epidermal cells in the ovaries), are best explained by this theory. Ribbert has modified the theory as follows: the cells or cell groups loose their cohesion, not only before but also after birth, become isolated and finally develop into tumors.

2. The IRRITATION THEORY depends upon a previous inflammation, as well as traumatic influences. The external irritant causes a mechanical loosening of the cells and results in an inflammatory proliferation of the connective tissue. The detached cells (epithelial cells for example) may proliferate unrestrained into the lymph-spaces. Chemical irritants and parasites also cause loosening of the cells through the production of connective-tissue proliferations; the cells become isolated and proliferate. The development of papillomata after inflam-

mations of the skin, of sarcomata after bone fractures and of cancers from a cicatrix, are cited as examples of this method of tumor formation.

3. According to the INFECTION THEORY, either microörganisms are the direct or essential causes of the tumor (carcinoma, sarcoma, papilloma), or through certain influences the sound tissue cells take on an infectious character. The infection theory is supported by the analagous infectious tumors: experimental inoculation (sarcoma, carcinoma), as well as by the process of metastatic formation. Unobjectionable proof of the relations between microörganisms and tumors has not yet been presented; this is especially true of sarcomata and carcinomata.

4. According to the AGE THEORY of Thiersch, age has the following relation to the existence of tumors: In old age the resistance of the connective-tissue stroma is less than that of the proliferating epithelial cells. Cancer is the result of a "shifting of boundaries, and a boundary war of the epithelium against the connective tissue" (Boll). The change of the cell character (anaplasia), due to a stimulus of the proliferative force of the cells, results from the fact that in old age the dependence of individual cells upon their surroundings (altruism) is diminished; they become similar to the original, non-differentiated germinal cells (Hansemann). For further information concerning the etiology of cancer compare with the chapter on carcinoma.

ETIOLOGY OF TUMORS IN ANIMALS.—Upon this subject little is known. Many theories of medical science find place, with nothing further to support their claims, in veterinary science. Thus Plicque maintains that pressure from the bit causes carcinomata on the lips of horses; that they are caused in cats by the repeated bites of smaller animals (!!). In Germany these observations have not yet been made. Also the further theory, that subcutaneous fibromata are often the result of pressure from the saddle does not seem to be proved, it is not a genuine tumor, but a contused swelling (tumor fibrosus). Smith and Washburn attempted to produce infection in eleven bitches by means of coitus with a dog affected with sarcoma of the penis; it is alleged that the experiment resulted in sarcomatous nodules in the vagina. They have also transmitted sarcoma to other animals by means

of subcutaneous injections (?). With reference to the professed heredity of melanoma in horses, and cancer of the mammae in dogs, nothing definite is known. On the other hand, on the basis of my own experience, I am able to confirm the allegations of Plicque, that young dogs seldom or never suffer from carcinomata, while old dogs are frequent sufferers from this affection. In at least 262 carcinomata in dogs I have never seen one in an animal less than two years of age. Also the 49 cases of carcinomata claimed to have been demonstrated in cattle (inner canthus of the eye) by Loeb and Jobson were confined exclusively to animals over six years of age. With reference to the influence of nourishment it may be said that animals fed on a meat diet are possibly predisposed to carcinoma. According to our experience dogs suffer from cancer more often than swine or cattle. Carcinomata are also common in horses. The claim of Trasbot, that cancer can be experimentally produced by feeding nourishment rich in albumen, is more than problemetical (compare with the chapter on carcinoma).

CLINICAL SYMPTOMS.--According to the character of the tumor and the various stages of its development, these are extremely variable. Cf: "Special Forms of Tumors." The development may be rapid or slow; it may proceed from the center of the growth (concentric development, growth by intussusception); or from the periphery (eccentric growth, growth by apposition). In the first case the tumors are circumscribed, in the latter they are diffuse or accompanied by daughter tumors. Tumors are often observed undergoing changes known as regressive metamorphosis; namely, fatty degeneration, caseation, calcification, cornification, chondrification, and ossification, mucous, colloid, and cystic softenings, deposits of cholesterin, amyloid degenerations, and pigment formation. When tumors become infected they react as do other tissues, becoming inflamed, ulcerative, necrotic, and ichrous. The general condition is not affected in non-malignant new formations (fibroma, lipoma, papilloma, osteoma, etc.). Malignant tumors on the other hand, especially carcinomata, in addition to metastatic formation result in a general derangement of the nutrition; this is characterized by emaciation, anaemia, hydraemia (cancerous cachexia), in which important nourishment is removed from the body on the one side, and toxic materials are taken up by the blood on the other (auto-intoxication). As

a result of ulceration of their surfaces many growths are hemorrhagic: chronic epistaxis in ulcerative angioma, adenofibroma, and carcinoma of the nasal septum of the horse; chronic hematuria in carcinoma of the bladder in dogs. Finally tumors may cause secondary derangements of neighboring organs by compression (melanoma of the parotid region, of the rectum, on the tail; tumors in the air passages, in the brain, in the spinal marrow, in the vicinity of large vessels).

DIAGNOSIS.—The diagnosis of a tumor as such, that is, differentiation from other swollen conditions, especially inflammatory, is not difficult. Tumors usually develop slowly and without inflammatory symptoms (pain, increased heat). Hematomata are differentiated from new formations by their rapid, sudden formation. In contrast to a phlegmon or abscess, inflammatory symptoms usually fail in the development of tumors, this is especially true of pain and increased heat. Only chronic hyperplastic inflammatory processes are able, under certain conditions, to simulate tumor formation to such a degree that diagnosis becomes extremely difficult. Examples of this are seen in the wart-like formations which follow dermatitis chronica on the flexor surface of the fetlock (dermatitis verrucosa), in the formation of exostoses after periostitis, as well as in keloids in a cicatrix.

DIFFERENTIAL DIAGNOSIS.—The differential diagnosis of individual tumors is more difficult. A classification of tumors can seldom be made on their macroscopic appearance; a microscopic examination is more valuable for making the special diagnosis. For making a purely clinical macroscopic examination the following points are of value:

1. The seat of the tumor with reference to the nature of the tissue involved is often an index to its character. According to experience, the penis, the testicles, and the mammae are frequently seats for the development of carcinoma, sarcoma, and adenoma; the periosteum for osteoma and sarcoma; the spermatic cord for botryomycoma; the skin for

fibroma, carcinoma, and papilloma; the subcutem for lipoma and fibroma; the nasal cavities for myxofibroma and adenofibroma; the maxillary and frontal sinuses for sarcoma and carcinoma; the nerves for neuroma.

2. Occasionally the size and development of the tumor is an index for its diagnosis. The malignant tumors are usually larger and develop more rapidly than the non-malignant. Sarcoma and botryomycoma in the horse sometimes develop very rapidly and attain an immense size. In the horse many sarcymata of the eye have a formidable development. Soft fibromata are characterized by a relatively rapid growth. Occasionally it is important to note whether the tumor is single or developing in several places. Papilloma and fibroma have a tendency to the production of multiple new formations (papillomatosis, fibromatosis), this is also true of botryomycoma. Sarcoma, carcinoma, and actinomycoma are multiple when metastatic formation results in generalization (sarcomatosis, carcinomatosis).

3. The surface of the tumor is rough in papilloma, botryomycoma, and carcinoma; lobulated in lipoma; comparatively smooth in many sarcomata and fibromata.

4. The consistency is softest in round-celled sarcomata, soft fibromata, lipomata, and myxomata, as well as in many cysts; carcinomata and hard fibromata are more firm; enchrondromata and osteomata are as hard as cartilage and bone.

5. The relation of the tumor to the skin or to the neighboring tissues, is of great diagnostic importance in malignant new formations (sarcoma, carcinoma) as they have a strong tendency to include the surrounding tissues in their processes of degeneration. They are, therefore, less sharply defined than the non-malignant tumors (fibroma, lipoma, papilloma); carcinomata frequently present superficial ulceration. Carcinomata and sarcomata frequently attack deeper underlying tissues, even involving the bone.

6. Under certain conditions the race may be of importance. In cattle actinomycotic and tubercular new formations are common; in horses, botryomycomata; in dogs, car-

cinomata. Grey horses are frequently affected with melanosarcoma.

7. In doubtful cases age may be of importance in the diagnosis of cancer; young animals are seldom affected with cancer, on the other hand, they are frequent sufferers from sarcoma, lipoma, and papilloma.

8. Swelling of the neighboring lymph glands is characteristic of malignant new formations, this is especially true of cancer and sarcoma (metastasis).

STATISTICS.—With the assistance of the statistical publications of Johne and myself, as well as the clinical annuals of the veterinary schools at Berlin, Munich, and Dresden, Casper has arranged statistics on tumors in the domestic animals from various points of view (Pathologie der Geschwülste bei Tieren. 1899). Among 86,000 diseased horses, 1131 (1.3 per cent) were affected with tumors; among 85,000 dogs, 4029 (4.7 per cent) were similarly affected; among 5,000 cattle, 102 (2 per cent) were affected with new formations. In the years 1886–1894, I operated on 643 new formations in dogs. Of these, 262 (40 per cent) were carcinomata and adenomata; 97 (13 per cent) fibromata; 65 (10 per cent) papillomata; 44 (7 per cent) sarcomata; 39 (6 per cent) lipomata; 2 (0.3 per cent) angiomata. In the years 1895–1902, I operated on 200 cases of new formations in the horse; 25 per cent of these were sarcomata, 20 per cent botryomycomata and fibromata, and 10 per cent were carcinomata. Therefore, sarcoma, botryomycoma, fibroma, and carcinoma are the most frequent tumors in the horse. These four kinds of tumors form three-fourths of all new formations in the horse. They are more frequent than cicatricial keloids, keratomata and papillomata. The following are the least common: lipoma, genuine osteoma, atheroma, adenofibroma and myxoma of the nasal mucous membranes. The statistics of the Pathological Institute (Casper, Johne), which include new formations of the internal organs that are not observed by the surgeon, afforded facts in accordance with clinical observations: that carcinoma is much more frequent in dogs than in horses or catttle; and that in the two latter species sarcoma is more frequent than carcinoma. Among 123 new formations in the horse, 60 were sarcomata (47 per cent), 28 carcinomata (22 per cent); among 93 new formations in the dog, 48 were carcinomata (52 per cent), 26 sarcomata (28 per cent); among 104 new formations in cattle, 36 were sarcomata (35 per cent), 28 angiomata (27 per cent), 8 carcinomata (8 per cent). With reference to the topographical distribution of tumors the following observations were made: carcinomata were most often found in the kidneys,

the mammae, the maxillary sinuses, the thyroid glands, the skin, the lymph glands, and the testicles; sarcomata were most often found in the lungs, the liver, the lymph glands, the thyroid gland, the mammae and the kidneys. Compare with statistics on carcinoma.

TREATMENT OF TUMORS.—In many cases, especially in non-malignant forms, treatment is superfluous (blemish). When treatment is indicated they should be operated at the earliest possible moment. Operation consists in removal with the knife, scissors, or curet. Early operation is especially indicated in sarcoma, carcinoma, and botryomycoma (fistula of the spermatic cord). When an operation is followed by a recurrence of the tumor it indicates that small pieces of the tumor remained. Pedunculated new formations, as well as tumors in the body cavity (polypi of the nose, vagina, and rectum) may be removed by tearing and twisting, by means of a ligature (ligation of the neck of a tumor), or with the ecraseur. The galvanocautery loop, employed in human surgery, is too complicated for veterinary use. In many cases the firing iron is indicated, especially the thermocautery, this acts as a hemostat during the operation, healing follows under an eschar which takes the place of a bandage. The earlier extensively employed drugs should only be used in those cases where an operation is impossible, or for econimic reasons is not practical (formaldehyde in many cases of cancer of the hoof). The recent treatment of certain tumors with iodid of potash is of some importance. It is a specific for goitre, as well as actinomycosis of cattle (not, however, against botryomycosis of horses). Iodid of potash may either be administered internally, or applied externally in the form of Lugol's solution; tincture of iodine is active when applied externally or by means of injections. The internal administration of arsenic has a similar influence on papillomata. The parenchymatous injection of other remedies (alcohol, acetic acid) is of doubtful efficacy, the same is true of treatment with the aneline dyes; the same may also be said of the artificial production of erysipelas for the relief of carcinoma, a few examples of which have been followed by success in human medicine. Concerning the importance of the serum therapy compare with the chapter on "carcinoma." Finally, the recently employed artificial inocculation of malaria is of very questionable value.

II. SPECIAL KINDS OF TUMORS.

A. Connective-Tissue New Formations.

1. FIBROMA.

Forms.—A fibroma or fibroid (connective-tissue tumor) is a desmoid tumor composed largely of connective tissue. Two forms are recognized: 1. Hard fibroma (fibroma durum, desmoid) is characterized by a hard, firm consistency; when cut it presents a white, tendinous, glistening surface; microscopic examination shows it to be composed principally of straight, stratified, or crossed connective-tissue fibers with a very few cells.

2. Soft fibroma (fibroma molluscum) is less common; it is soft in consistency; when cut it presents a light-grey transparent surface; under the microscope it is seen to be composed of loose moist connective tissue with very many connective-tissue cells. Between the soft and the hard fibromata there are many transitional forms. One also differentiates circumscribed and diffuse, simple (solitary) and multiple fibromata (fibromatosis). Pedunculated fibromata on the mucous membranes are termed polypi (fibroma pedunculum); similar fibrous new formations on the skin and subcutem are termed cutis pendula (see below). Fibrous proliferations in cicatricial tissue are termed keloids. Mycofibroma is a special infectious form due to the activity of the botryomyces fungus (botryomycoma). Finally, mixed tumors with other new formations are very frequent, for example, fibrosarcoma, fibrolipoma, fibromyxoma, fibroneuroma, fibroadenoma.

With reference to the causes of fibromata nothing definite is known. Recently it has been attempted to associate their development with traumatic and inflammatory influences. Their relation to inflammatory cicatricial tissue, especially the cicatricial keloids, as well as to the inflammatory connective-tissue hyperplasias (elephantiasis, tumor fibrous) has been considered. At the most, repeated injuries or chronic inflam-

mations are only occasionally the cause of fibroma formation. The principal cause, for the want of better knowledge, seems to lie in a fibromatous predisposition. This explains the cases of congenital fibroma (congenital anlage of fibromata). The multiplicity of cutaneous fibromata in dogs and horses also speaks for the presence of an internal predisposing cause.

OCCURRENCE.—Fibromata are benign, develop slowly, are usually roundish, circumscribed, nodular, smooth on the surface, firm, non-hemorrhagic painless new formations of a uniform consistency. They are very common in the domestic animals and may develop in any organ that contains connective tissue. Their favorite seats, therefore, are in the subcutem, the submucosa, the periosteum, and the subfascial and intermuscular connective tissue; they are also common in the uterus and in the nerves (so-called neuromata are nothing more than fibromata of the nerves). The following forms are of surgical importance in the domestic animals:

1. Fibromata of the skin and subcutem are most frequently observed in horses and dogs. In the horse they are especially frequent on the head, shoulder, and region of the withers, as well as in the sheath. Ordinarily they are solitary, sharply circumscribed, from the size of a pea to that of a fist. Occasionally they are multiple, as many as one hundred have been seen on a single horse (Siedamgrotzky). Subcutaneous fibromata average about the size of a goose-egg; sometimes they lie in a capsule from which they may be removed after a skin incision has been made (Möller). In rare cases fibromata are found in the shoulder region in the form of so-called shoulder abscesses (personal observations). Bayer has observed fibromata on the scrotum of a horse that were multiple, soft, and recurrent after removal. Many fibromata of the horse are not genuine fibromata, but mycofibromata (compare with the chapter on botryomycoma). Many inflammatory connective-tissue hyperplasias are erroneously termed fibromata; to this class belong those found in harness positions in horses and cattle (see below). According to my own experience cutaneous fibromata are very common in dogs. They are often multiple, especially on the thorax, on the ex-

tremities, on the ears and eyes, on the back, on the tail, and in the mammae. As in horses, hard fibromata are most common; the soft form are seldom found. Their size is variable; as a rule they are small, sharply circumscribed, hard, smooth, and intact on the surface. Pendulous fibromata are occasionally observed. In cattle myxomatous fibromata are occasionally seen on the tail (Mayr). Peter has described a fibroma on the head of a cow; the tumor weighed 11½ kg., was pendulant, and combined with cutaneous horn. On the other hand, the subcutaneous, calcified, new formations of fibrous tissue in the vicinity of dead larvae are not genuine fibromata (hypodermoliths of Caparini).

2. Fibromata of the mucous membranes are either flat, circumscribed proliferations with a broad base, or pedunculated tumors (polypi, polypoid fibroma); their consistency is soft. Not all polypi of the mucous membranes described in the literature are genuine fibromata. Many other tumors of the mucous membrane have a pedunculated form; for example, lipoma, actinomycoma, and sarcoma. According to the seat, one speaks of nasal, pharyngeal, laryngeal, vaginal, cystic and rectal polypi.

In the nasal cavities the flat and polypoid fibromata (myxofibroma) of the nasal mucous membranes are of special importance in the horse; this is due to the fact that so-called nasal polypi produce a stenosis of the nasal passages, causing dyspnoea, chronic unilateral nasal catarrh, and in ulcerative degeneration, an ichorous, fetid nasal discharge with unilateral swelling of the glands (suspected glanders).

In the uterus and vagina of the horse, cow, dog, and pig, pure fibromata and mixed tumors (fibromyoma, fibromyxoma, fibrolipoma) occur in various forms.

Fibromata of the vagina are frequently pedunculated (vaginal polypi). Typical fibromata from the size of a cherry to that of a walnut are found in the vagina of the dog. These vaginal polypi have a firm, hard consistence, occasionally they are long and bottle-shaped; they present no inflammatory symptoms. They are readily differentiated from those chronic inflammatory swellings of the mucous membranes which also develop in the form of pedunculated new forma-

tions (so-called plicae polyposae). Fibromyomata in the uterus of cattle and swine sometimes reach an enormous size (50 to 200 pounds). In such cases the uterus extends into the abdominal cavity. Tumors which extend through the os uteri into the vagina are smaller. Polypoid fibromata may also develop in the pharynx or larynx (the so-called laryngeal polypi in cattle are usually of an actinomycotic nature), in the guttural pouches, in the bronchi (polypi which follow tracheotomy in the horse are usually granulomata or botryomycomata), in the rectum, bladder, urethra, and teat canals.

3. According to Kitt, fibromata of the udder are characterized by hard, nodular, sharply circumscribed swellings; in the dog they are from the size of a dove's egg to that of a man's fist. They are composed of a mucoid and gelatinous substance (myxofibroma). Occasionally, in addition to proliferation of the connective tissue, the glandular tissue also proliferates (adenofibroma). Similar fibromata are found in the testicles of dogs and horses.

4. In the internal organs fibromata are seldom of surgical importance. Kitt has observed a fibroma on the tongue of a cow; it was hard as a board, sausage-shaped, 16 centimeters long and 10 centimeters wide. Juredieu has described a fibroma of the pelvis of a dog; it was as large as a hen's egg. It is not known whether fibromata develop in the vertebral column of the domestic animals, thus causing paralysis from pressure on the spine (lumbar paralysis), similar to lipoma, sarcoma, and other new formations. They are found, however, in the form of osteofibromata in other osseous cavities, for example, the tympanic cavity of the horse (Fretjanow).

TREATMENT.—Treatment of fibroma consists in operative removal by means of the knife, scissors, ligature, etc. Large fibromata are extirpated with the scalpel and the wound sutured; small tumors may be removed in the same manner. In the latter, healing may be produced under an eschar by means of cauterization. Very large, diffuse fibromata, which cannot be entirely removed at one time may be operated on at different times; repeated partial operations until the enlarge-

ment is entirely removed. Operations upon polypoid fibromata are very difficult. When one can reach them with the hand (vagina, rectum) they may be ligated; ligation is more reliable when a double suture is passed through the neck of the polypus and tied on both sides. Polypi that cannot be so easily reached may be removed with the ecraseur, this applies especially to nasal polypi. In many cases they must be torn or twisted away with the hand or forceps.

KELOID.—A keloid is a tumor-like, fibrous, hard proliferation of the skin and subcutem; it usually develops from cicatricial tissue (cicatricial keloid). In contrast to this, a spontaneous (genuine) keloid has been differentiated. According to recent investigations the existence of a "spontaneous" keloid is questionable; this is due to the fact that experience has demonstrated that keloids usually develop after traumatic or inflammatory processes in the skin. The causes of keloid formation are not yet fully understood. Some maintain that its development depends on a specific infection of the wound, they claim that this accounts for its recurrence following operations; according to others, the existence of keloids depends on an individual fibromatous disposition of the body. In the domestic animals keloids are most often met with in the horse. They follow injuries to the coronet, the balls of the heel, the flexor surface of the fetlock joint, the flexor surface of the tarsal joint, as well as to the region of the tendons; occasionally they develop after gangrenous dermatitis (grease), after firing, and after the application of blisters. They form circumscribed, hard, fibroma-like new formations that are usually extensive in size; they are relatively rich in blood-vessels; in contrast to normal cicatricial tissue, they are covered with a thick layer of epidermis. To a certain degree they are a highly developed form of the so-called hypertrophic cicatrix (see page 22). According to my own observations the continual movement and irritation of a wound that is often very insignificant appears to be one of the principal factors on which keloid formation depends. I have never observed recurrence following operations. According to Labat, Leblanc, and others, on the other hand, many keloids are recurrent after excision; they caution, therefore, against the operation, and employ the elastic ligature (?) in combination with a disinfectant bandage applied daily. Johne has described a cicatricial keloid of the flexor tendons of a horse; this was in the form of a hard, tendinous oval tumor, 27 centimeters long and 18 centimeters wide, it was fungus-like, proliferated from the tendon cicatrix, and adhered to the tendon-sheath and skin. I have observed many similar forms of tendinous keloids on the extensor tendons of the coronet following treads on the coronet.

ELEPHANTIASIS.—The name elephantiasis, (schleroderma, schlerosis, pachyderma) indicates a connective-tissue hyperplasia of the skin and subcutem, which results in a pronounced thickening of those parts of the body involved. It is very rare that elephantiasis is caused by a genuine fibroma; in such cases it assumes the form of a diffuse fibromatosis. In the horse it is usually the product of chronic inflammation of the skin or subcutem (chronic indurative dermatitis and phlegmon following scratches and phlegmon: so-called thick leg, elephant leg); or specific, chronic inflammatory processes in the vicinity of the lymph-vessels (glanders). Elephantiasis may also be caused by chronic edema in the vicinity of the veins, as well congenital dilitation of the lymph-vessels. In man the principal causes of elephantiasis are leprosy and filaria sanguinis; according to the condition of the skin the following forms are recognized: elephantiasis glabra, verrucosa, ulcerosa, papillaris. Occasionally there seems to be an individual predisposition to fibrous hyperplasias (elephantiasis). Labat observed this in a horse on which a blister (potassium bichromate) had been applied after firing; this was followed by an extensive (60–70 centimeters large) fibrous new formation on the limbs. Similar observations have been made by Rabe and Lustig.

TYLOMA.—Tylomata are fibrous dermal proliferations (continual pressure from the saddle) that develop from the subcutaneous tissue; they are the result of a chronic, hyperplastic inflammation. They belong, similar to elephantiasis, not to the genuine new formations, but are to be considered as chronic, inflammatory, connective-tissue hyperplasias. In contrast to the circumscribed fibromata they are diffuse hard thickenings of the skin and subcutem, they are found at the seat of the collar in horses, on the carpus in cattle, on the elbow and ischial tuberosity in dogs. They are sometimes so heavy as to cause a suspension of the fibrous thickenings of the skin (cutis pendula). Occasionally they are circumscribed, when it is very difficult to differentiate between them and genuine fibromata. Callosities of the skin, in contrast to tylomata, consist of a hypertrophy of the epidermis, there is always present, however, a chronic, connective-tissue hyperplasia of the cutis.

RHINOSCHLEROMA.—According to Hebra (1870) rhinoschleroma in man is a specific tumor-like disease characterized by the formation of hard nodules in the skin and mucous membranes of the nose, they afterwards extend to the lips, the superior maxillae, the nasal cavities, the pharynx, etc. The course is chronic and incurable, it occurs only in certain environments and countries (Southern Russia, Eastern Provinces of Austria, Central and South America). The principal symptoms consist of cartilaginous, painful thickenings of the nose which extend into the deeper tissues,

as well as on the surface; ulcerative degeneration sets in, and they are finally transformed into connective-tissue folds. This results in stenosis and deformity of the nose, mouth, gums, and pharynx. The rhinoschleroma bacilli have been discovered as the cause of this peculiar affection; they are found in the large, swollen, non-nucleated cells of the diseased tissues. Transmission of this bacillus to other animals has not been followed by results.

In veterinary literature various affections of the horse have been described under the name rhinoschleroma (Grawitz, Dieckerhoff, Rabe, Schulz and others); in many essential points they are different from the disease described under that heading in man. In the horse it is manifestly an entirely different affection. Möller and Johne also maintain that this is an incorrect term for nasal tumors in the horse. According to Kitt the process is an adenofibrous hyperplasia of the nasal mucous membranes (adenofibroma). Under the microscope one finds fibrous hyperplasia and amyloid induration of the connective tissue, pronounced proliferation of the mucous glands, as well as new formation, and dilitation of the vessels. Because of the rich blood-supply it may be easily confused with angioma. The new-formations consist of hard, nodular, lobulated, smooth, flat, lardaceous, transparent proliferations located close together; ordinarily they are found only in the lower third of the nasal cavity (pavement epithelium); they are usually bilateral, and are hemorrhagic on the surface (epistaxis). Ulceration, dried blood, and cicatricial formation may be present (confusion with glanders). I have operated several cases in the horse with good results.

II. LIPOMA.

FORMS.—Lipomata or fatty tumors are composed principally of fat-cells which lie in a framework of connective tissue. In structure they are similar to normal fatty tissue, they may occur in any part of the body where that tissue is present, especially when it exists with connective tissue. They are usually located, therefore, in the subcutaneous, submucous, subserous, subsynovial, and intermuscular connective tissue. If the fat-cells are in excess it is termed a soft lipoma; when more connective tissue is present it has a firm consistence (hard lipoma). Occasionally lipomata are pedunculated (lipoma pendulans, lipoma polyposum). Lipoma arborescens is a special form that develops in the vicinity

of joint-capsules, after rupture of the capsule the lipoma proliferates in the form of a tree-like growth. Like fibromata, mixed forms are common: lipofibroma (lipoma fibromatosum, steatoma), lipomyxoma (lipoma myxomatosum).

OCCURRENCE.—Lipomata are not common. They form circumscribed, roundish or oval tumors; occasionally they are pedunculated and therefore pendulant; some are small, others attain an enormous size; they are nodular, lobulated, and occasionally very soft; they crepitate in a peculiar manner, apparently fluctuate on palpation, and develop very rapidly. Other forms are hard, develop slowly, are usually solitary, but are sometimes multiple. They are non-malignant tumors and never spread by metastasis. It is a peculiar fact that they are not confined merely to well-nourished animals, but often accompany anemic conditions; when the animal is affected with general emaciation their size does not decrease. They may undergo caseous degeneration. When injured, suppuration may occur; occasionally they are congenital.

Of those lipomata which occur in domestic animals the following are of importance:

1. Subcutaneous lipomata are especially common in horses and dogs. In the horse they occur on the sheath, tail, and anus (Bayer), also on the walls of the thorax and abdomen, and on the posterior limbs; they are often multiple. The vicinity of the biceps and knee-joint seems to be a favorite seat for their congenital appearance in foals (personal observations); in this case they are circumscribed and develop very rapidly. Möller observed a lipoma in the vicinity of the lower end of the biceps femoris that weighed 25.5 kilograms, Rhode observed one about the size of two fists just above the patella on the external surface. In dogs, where lipomata occur principally on the inner surfaces of the limbs, on the thorax, and on the shoulder, I have observed twelve cases. Their form is round or cylindrical, the size is extremely variable, occasionally attaining that of a man's

head. They develop slowly, have a lardaceous consistency, lobulated structure, and many times a pedunculated form (pendulant). One also occasionally observes wandering lipomata.

2. Pedunculated Lipomata and lipofibromata are sometimes found on the mucous membranes of the horse in the upper portions of the nasal cavities; they originate from the nasal septum, the turbinated bones, or the ethmoid bone (Gurlt). Occasionally they develop in the larynx; Fricker has described a case of lipoma on the anterior surface of the epiglottis in a horse (laryngeal polypus), the tumor was as large as a potato. Submucous lipomata in the rectum cause obstruction and colic (Brose, Lessa). Vaginal polypi are occasionally found in the mare on the vaginal floor. Polypi are also found on the membrana nictatans in dogs (personal observations).

3. Subperitoneal lipomata of the abdominal cavity are relatively frequent in the horse; they constrict the small intestines or rectum and lead to fatal colic. The new-formations have a long neck, are pendulant, and originate from the omental attachment; they possess no surgical importance. Werner, in cattle, has diagnosed a lipoma per rectum; the tumor was the cause of colic, and removal through the flank resulted in a satisfactory termination. On rectal exploration of a horse suffering from colic Sommer recognized the presence of a tumor anterior to the bladder; on post mortem this proved to be a lipoma.

4. Lipomata are seldom found in other organs. Occasionally they develop from the dura; at other times from the pia (Kühnaeu). Pfister published the records of a case where a lipoma was found to be the cause of lumbar paralysis in a cow; the tumor was located in the lumbar region of the vertebral column. Ebinger has described a similar case. According to Stockfleth they are occasionally found in the udders of fat bitches. Esser removed a lipoma that weighed four kilograms from the left half of the udder of a mare. According to Montfallet lipomata in the udder of the bitch are usually perimammary, seldom interglandular.

Treatment of lipomata consists in extirpation with the knife; pendulant lipomata may be removed by means of a ligature.

III. MYXOMA.

Definition and Occurrence.—Myxomata (mucous tumors) are composed of a gelatinous mucous tissue, with stellate, branched, connective-tissue cells, an abundance of mucous substance is also interposed. Their independent existence as tumors is disputed. Apparently they are nothing more than edematous fibromata or lipomata (Köster). The soft, edematous, gelatinous, swollen lipomata and fibromata are better termed myxofibromata and myxolipomata. Other mixed forms are: myxomyomata, myxochondromata, fibrosarcomata, and other muco-edematous forms. Myxomata, like fibromata and lipomata, are non-malignant tumors; they develop in the subcutis, submucosa, subserosa, on the periosteum as well as beneath the fasciæ. Occasionally they become sarcomatous.

Myxomata and myxofibromata appear, relatively, to be most frequent in the nasal cavities of the horse, where they result in the formation of so-called nasal polypi (Möller, Hamburger, personal observations). Pedunculated myxofibromata are also observed on the floor of the rectum in the horse, they are in the form of bean-shaped rectal polypi the size of a child's head (personal observations.) According to Kitt myxomata occur in cattle in the sinuses of the head where they may become three times the size of a man's fist; they are smooth, nodular or lobulated, and are composed of glassy, swollen, mucous vesicles containing masses of connective tissue. Myxomata have also been seen in the sinuses of the head in sheep (Cagny); and in the bladder in cattle (Leisering). Myxomyomata, myxofibromata, and fibromyxosarcomata have been observed in cattle in the uterus (Kitt); in the mammæ of mares and bitches (Kitt, M'Fadyean); in the subcutis of the horse (Ehlers); in the cutis of calves in the form of soft tumors the size of hens' eggs on the inferior

surface of the abdomen (Möller); as well as beneath the dura of the spinal marrow thus causing spinal paralysis (Bratschikow, Holzmann). Finally, myxoma has been observed in the placenta (De Bruin).

Treatment of myxomata of the nasal mucous membranes consists in tearing out, and twisting off, as well as extirpation after previous trepanation of the nasal cavities.

MUCOUS DEGENERATIONS OF THE TURBINATED BONES.—Under this heading Sand (Monatshefte für Tierheilkunde. 1893) has described a tumor-like swelling of the facial bones of foals; it was characterized by dyspnea and nasal discharge, as well as mucous softening of the turbinated bones, and the osseous walls of the superior maxillary and frontal sinuses. The latter become dilated, and are affected with hydrops and empyema. I have observed similar cases.

MYXEDEMA.—The following symptoms have been observed following disease or removal of the thyroid gland in man: edematous swellings of the skin of the face and extremities (collections of mucin), with pronounced general decrease in nourishment, strength, and psychic activity (cachexia strumapriva following thyroid operations; related to cretinism). Recently myxedema has been successfully treated in man by the administration of thyroid-gland substance and thyroid-gland preparations (iodothyrin). The existence of myxedema is explained as follows: it is the function of the thyroid gland to prevent the formation of mucin in the body; in myxedema this function is destroyed (?).

IV. CHONDROMA.

NATURE AND OCCURRENCE.—Chondroma (enchondroma, ecchondrosis, cartilaginous tumors) is a name applied to tumors composed largely of cartilage; this form of new-formation is apparently rare. Hyaline cartilage is the principal component (large or small cells). They are found in the following places:

a) in cartilage (ecchondrosis or hyperplastic chondroma);

b) in bones, on the ribs, in the pelvis, on the vertebral column, on the first phalanx, on the ethmoid bone, and sphenoid bone;

c) in the udder, testicles, thyroid gland, in the parotid, in the subcutem, and in other organs that are normally free from cartilage (enchondroma in the nar-

row sense; heteroplastic chondroma). The occurrence of chondromata in these organs is partly due to a metaplasia (metamorphosis) of connective-tissue cells and endothelial cells into cartilage cells, partly to aberration of germinal cartilage.

Chondromata are benign tumors, they are usually solitary but occasionally multiple; they are spherical in form (udder), and occasionally very large. They are nodular, elastic, firm, and painless. Chondromata are usually observed in combination with other tumors (chondrofibroma, osteochondroma, chondrosarcoma); they may undergo softening, cystic degeneration, calcification and ossification. An osteochondroma is composed of material similar to non-calcareous (osteoid) bone tissue.

In the domestic animals chondromata are most often found in the mammæ of the bitch; they are from the size of a pea to that of a man's fist, round, firm, painless, and sharply circumscribed from the normal glandular tissue; they are nodular and are not adherent to the skin. Cartilaginous, nodular, sharply circumscribed chondromata are repeatedly found in the testicles of the horse (Kitt). They are also frequently found on the costal cartilages of the horse and ox; in this case they may possibly have a traumatic origin (Bruckmüller, Kitt, Hahn, personal observations). Chondromata are found in the vicinity of the thyroid gland (Siedamgrotzky, Zahn). Seidamgrotzky described a chondroma that was twice as large as a man's fist, it was located on the first phalanx of a cow. They have also been found on the maxillae and in the nasal cavities of horses and dogs (Gurlt, Kitt); on the vertebral column of a dog with spinal paralysis (Smith); in the vicinity of the ear in cattle; at the base of the second and third cervical vertebræ, hard tumors weighing 4½ kilograms and as large as a man's head (Morot); in the subcutis of cattle, horses, and dogs (Janson, Morot, Leisering, Ostapenko); on the vocal cord of a horse (Lee); as well as in the crystalline lens of a foal (Renner).

Treatment consists in extirpation; when large chon-

dromata are present in the udder it should be amputated. In my experience many cases of chondroma of the udder in dogs do not require treatment; this is due to their stability and non-malignant character.

V. OSTEOMA.

NATURE AND OCCURRENCE.—An osteoma or bone tumor is composed largely of osseous material. It is analogous to chondroma. With reference to their occurrence they may be arranged as follows:

a) Those occurring in bone (hyperplastic osteoma); they develop partly from the periosteum, partly from the tela ossea, and partly from the bone-marrow. They are known by various terms: exostoses, osteophytes, hyperostoses, enostoses. To this class also belong new formations of bone due to inflammation (exostoses).

b) Osteoma may also occur in the following organs, although they contain no bone-cells: the mammae, parotid, brain, muscles, and other organs that normally contain no bone-cells (heteroplastic osteoma); they are either due to metaplasia, or aberration of embryonic tissue.

According to the consistency one speaks of an osteoma durum or eburneum (hard as ivory), spongiosum (spongy), and medullare (composed largely of marrow). According to the covering it is termed a cartilaginous exostosis (covered with cartilage), or a bursal (located beneath a mucous bursa). Mixed forms of osteomata are also frequent: osteosarcoma, osteofibroma, and osteochondroma. Osteomata with broken attachments so that they lie free in the cavities of the head are termed dead osteomata. Unattached osteomata are located in tendons and muscles away from the bone.

Osteomata form very hard, bone-like, painless, benign tumors; they are more or less sharply circumscribed, partly multiple, partly solitary, and are usually located beneath the skin. In the domestic animals they are more frequent than

chondromata. The following forms are of practical importance: osteomata that frequently occur on the inferior maxilla and metacarpus, and are usually due to an ossifying periostitis, occasionally, however, they are genuine tumors (pedunculated fungoid and knob-like osteomata on the free margin of the inferior maxilla); osteomata of the udder and testicles in horses, cattle, and dogs; of the crystalline lens in the horse; as well as those which occur in the cavities of the head of both the horse and cow. The latter apparently develop from rudimentary cartilaginous areas of the sphenoid and ethmoid bones and occasionally form so-called total osteomata (ossified brain). Odontomata and dental osteomata of the teeth, on the maxillæ, and on the petrous portion of the temporal bone, are special forms.

Treatment consists of removal by means of the saw, chisel, or trephine.

VI. MYOMA.

Nature and Occurrence.—A myoma or muscle-tumor is composed of muscle-fibers. According to the character of the fibers they are classified as follows:

(a) Leiomyomata (myoma lævicellulare), the more common form, are composed of non-striated muscle-fibers. They are usually found in the stomach, intestines, uterus, in the bladder, as well as metaplastically in tumors of the kidneys, testicles, and ovaries; occasionally they are combined with other tumors (myofibroma).

(b) Rhabdomyoma (myoma striocellulare) is rare; it is composed of striated muscle-fibers, and is occasionally found in mixed forms (myosarcoma).

Myomata are of slight surgical importance as they are usually found only in the internal organs. Kitt has described a subcutaneous leiomyoma of the crural muscle, it weighed 250 grams. Gratia has described a rhabdomyoma which had its seat on the vagus at about the middle of the cervical portion in the horse Monod has operated an encapsuled rhabdomyoma as large as a goose-egg in the

vicinity of the shoulder in the horse. Siedamgrotzky has observed a leiomyoma of the testicles; Kolesnikow observed a rhabdomyoma of the tail. Leiomyomata of the uterus are far more frequent (Kitt, Frank, Johne, Eber, Gratia, Harms); the same is true of pedunculated leiomyomata of the vagina that cause sterility (De Bruin); leiomyomata that lead to stenosis of the intestines (Schutz, Tetzner, Cadeac) and stomach (Rabe, Lothes); as well as those of the bladder (van Tright, Lienaux, Voirin, personal observations), and kidneys (Johne). With reference to the treatment, myomata of the uterus are experimentally treated, as in the human family, with internal administration of ergot.

VII. NEUROMA.

NATURE AND OCCURRENCE.—Two varieties of new formations are described under the term neuroma, or nervous tissue tumors.

(a) Genuine neuromata are a new formation composed essentially of nerve-fibers; they may be medullated (neuroma myelinicum), or non-medullated (neuroma amyelinicum). This form is very uncommon in man, and has not been observed in the domestic animals.

b) False neuroma is a fibroma or myxoma of the nerves (neurofibroma, neuromyxoma). It develops from the connective tissue of the perineurium, and is composed principally of connective tissue or mucous tissue. These neurofibromata in the horse occasionally develop as a result of neurectomy when the operation is followed by a neuritis, they also occur in saddle horses on the internal tibial nerve. Analogous to the amputation-neuromata in man, they form spindle-shaped or oval enlargements on the central end of the nerve; they are white in color, from a bean to a dove's egg in size, and cause lameness. They have been seen on the median nerve (Möller, Trasbot and others, personal observations); on the volar and planter nerves (Hardy, Brauel, Rey and others, personal obser-

vations); also on the peroneus (Bayer), and tibialis (Becker). That form of false neuroma recognized in man under the name helicine neuroma (plexiform neuroma) has been repeatedly observed in cattle (Morot, Ostertag, Tiemann, Matschke); it is multiple and develops in the form of nodules and cords. Its favorite seat seems to be in the brachial plexus, the cervical, thoracic, and abdominal gangliæ of the sympathetic, as well as on the intercostal nerves. In one case, multiple neurofibromata produced symptoms of paralysis in the ox (Matschke). Zietschmann described two other cases of multiple neuroma formation and chronic interstitial neuritis of the brachial plexus in cattle, there were no special symptoms of paralysis, the enormous anatomo-pathological changes were remarkable when contrasted with the clinical symptoms (slight motor weakness.) One case of helicine neuroma has also been observed in the horse (Leisering).

Gliomata are a result of proliferation of the neuroglia cells (supporting cells) of the brain and spinal marrow, they are of no importance from a surgical standpoint. So-called glioma of the retina is a sarcoma (gliosarcoma).

Treatment of neurofibromata consists of free exposure and extirpation, recurrence is possible and the neurectomy may have to be repeated.

VIII. ANGIOMA.

FORMS.—Angiomata or vessel-tumors either originate from blood-vessels (hemangioma, angioma in the narrow sense), or from the lymph-vessels (lymphangioma). Angioma is a collective term for various tumors which are composed principally of dilated hypertrophic, abnormally twisted, and newly-formed vessels. The following forms are recognized:

a) Angioma simplex (teleangiectasis, nævus, nævus vasculosis, birth-mark, fire-mark) is composed of dilated and newly-formed capillaries of the skin.

b) Angioma cavernosum (tumor cavernosus) is

a venous new-formation of the skin, mucous membranes (nasal mucous membranes), bones, liver, etc. It is a cavernous-like body containing large spaces that communicate with one another.

c) Angioma racemosum (helicine angioma) is characterized by its serpentine structure.

d) Angioma lymphaticum (lymphangioma, lymphangiectasis) is a rare form; it is composed of dilated and newly-formed lymph-vessels. It occurs in the skin (congenital elephantiasis), the tongue (macroglossia), and the lips (macrocheilia). It develops in the form of an angioma simplex, cavernosum, and cysticum.

e) Fungus vasculosus (fungus hematoides) is not a genuine angioma, it is a term that indicates various extremely hemorrhagic new-formations.

Occurrence.—In the domestic animals angiomata are observed in various parts of the body. The most important are the superficial angiomata in the form of edematous areas on the nasal mucous membranes of the horse, they are usually cavernous, seldom simple, and lead to epistaxis, ulcerative formations, dyspnea, and suspicion of glanders. Deigendesch described a case of angioma which for ten years caused periodic epistaxis. Lübke saw a case of cavernous angioma of the mucous membranes of the nose and eyes in a horse; there was hemorrhage from these organs that even extended to the lachrymal duct. Schütz observed angiomatous ulcers on the nasal mucous membranes as large as a man's hand. Finally, angiomata of the nasal mucous membranes are many times confused with other hemorrhagic new-formations, especially the adenofibrous hyperplasias in the same region (see page 113).

According to Zschokke osteoangiomata at the base of the tail in cattle are not uncommon. They form tumors twice the size of one's fist, which grow entirely through the body of the vertebræ, are composed of numberless dilated blood-vessels, and are made up of a reticulated, spongy, bone substance. Rosenbaum observed a similar very hemorrhagic new-formation on the tail of an ox. Angiomata of the

skin and subcutem are less common in animals (Bonnet, Leisering, Johne, Möller, Siedamgrotsky, personal observations). Grebe has observed a cavernous angioma as large as a fist on the gums and lips of a horse; the animal died during operation. Zschokke has described an angioma at the base of the skull in a cow; it developed along the nerves which supply the external ocular muscle, causing its paralysis and strabismus convergens externus. Francesco has described an angioma on the penis of a horse; it was the cause of frequent and severe hemorrhage.

Leisering and Eggeling have seen angiomata of the vaginal mucous membranes in cows. Stenzel has investigated four cases of angioma of the udder in cows. Schindelka has described a lymphangioma of the mamma in a cat. Angiomata of the liver, which occur frequently in cattle and other animals, are of no surgical importance.

TREATMENT.—Healing of angiomata of the nasal cavities in the horse cannot often be attained because of their deep situation. Superficial angiomata of the skin are occasionally very difficult to extirpate on account of their size and extent. In human surgery the following methods of therapy are employed: Ligation of the blood-vessels which supply the part, cauterization, firing, puncture with the thermocautery, application of the galvanocautery, as well as the injection of liquor ferri chloridi, alcohol, tincture of iodine, and extractum secalis.

IX. LYMPHOMA.

NATURE.—Lymphoma (tumor of a lymph-gland) is a name used to indicate various disease processes of the lymph-glands.

a) Leukemic lymphoma during the course of leukemia.

b) Malign lymphoma during the course of pseudo-leukemia.

c) Lymphosarcoma, lymphadenoma, carcinoma and other genuine new formations in the lymph-glands.

d) Inflammatory hyperplasia of the lymph-glands following chronic inflammatory processses of neighboring organs (catarrh, strangles, glanders, tuberculosis, actinomycosis).

The so-called malign lymphoma (progressive hyperplasia of the lymph-glands, lymphadenia, lymphomatosis maligna, Hodgkin's disease, pseudo-leukemia) which frequently occurs in man, is also seen in cattle, horses, and dogs. Like leukemia, without however, a marked increase in the number of white blood-corpuscles in the blood, it is characterized by the enlargement of groups of lymphatic glands, or enlargement of the entire lymphatic system of the body. They are arranged in the form of multiple, nodular or clump-like, lardaceous, soft or hard, painless, often very large tumors in the vicinity of the intermaxillary glands, the superior, middle, and inferior cervical glands, the inguinal, knee, and pelvic glands. On account of the generalization of this disease surgical interference is of no use; treatment is confined to the internal administration of arsenic or iodid of potash. Solitary lymphomata in the intermaxillary space in the horse may be extirpated without difficulty. Operative removal for diagnostic purposes may be indicated (suspected glanders).

X. SARCOMA.

NATURE.—A sarcoma is a desmoid tumor which may be termed an atypical proliferation of the embryonic connective tissue. It is a malignant connective-tissue new-formation in which the cells (round-cells, spindle-cells, giant-cells, endothelial cells) are far in excess of the intercellular substance. They often develop very rapidly, when they are usually associated with metastatic formation through the medium of the veins. Sarcomata develop anywhere in the body where connective tissue is present. Their

favorite points of development are the periosteum, the bone-marrow, the lymph-glands, the cutis, the subcutaneous, submucous, and subserous (subperitoneal, subpleural) tissues, the eyes, the glandular tissues (testicles, mamma, thyroid), as well as the vessel-walls. Sarcomatous cellular activity is often followed by regressive conditions; these are softenings, cystic formations, hemorrhage, ulceration, and suppuration. As in other tumors, mixed forms are common; for example, fibrosarcoma, chondrosarcoma, myxosarcoma, osteosarcoma. With reference to the causes nothing definite is known. Recent theories concerning bacterial and protozoan irritants have not been sustained.

FORMS.—Sarcomata are characterized by many different forms. According to the structure and the forms of the connective-tissue cells the following principal types are recognized:

a) Round-celled sarcomata are composed of large or small round-cells (large and small round-celled sarcomata). The small round-celled sarcomata are especially malignant. They consist almost wholly of small round-cells, similar to white blood-corpuscles; occasionally they are combined with ameboid connective-tissue cells which multiply very rapidly. The consistency, therefore, is soft, marrow-like (medullary sarcoma), and the growth is very rapid.

b) Spindle-celled sarcoma is composed essentially of spindle-cells; it often develops from a fibroma (fibrosarcoma).

c) Giant-celled sarcoma is very malignant; it is usually found in the bone-marrow (myelogenous sarcoma, myeloid).

d) Stellate or "Netzzellen" sarcomata usually arise from myxomata (myosarcoma).

e) Sarcomata with polymorphous formation are composed of various forms of connective-tissue cells: round-cells, spindle-cells, giant-cells, reticular cells; there are many combinations of these cells (combined sarcoma).

f) Alveolar sarcoma is characterized by a gland-

and cancer-like alveolar structure; under certain conditions it is difficult to differentiate it from carcinoma. The alveolar, small and large round-celled sarcomata are of special importance; lymphosarcomata are examples of the former. In contrast to carcinomata of a similar alveolar structure, the alveolar sarcomata show an intercellular substance among their cells.

g) Angiosarcomata or endotheliomata (endotheliosarcoma, endothelial cancer, plexiform angiosarcoma, plexiform angioma, cylindroma, perithelioma) are angiomata with a sarcomatous proliferation of the cells of the vessel-walls. They develop from the following sources: the endothelial cells of the intima and perithelium (adventia) of the blood- and lymph-vessels, the lymph-cells of the connective tissue, as well as the endothelium of the pleura, the peritoneum, the dura, and the pia. They have been recently differentiated, then, as hemangiosarcomata (angiosarcoma of the blood-vessels) and lymphangiosarcomata (of the lymph-vessels). Depending on their origin on the inner or outer wall of the vessel they are termed intravascular (endothelial), and perivascular (perithelial). Angiosarcomata are very malignant; they show a tendency to hemorrhage and hyaline degeneration. They are easily confused with carcinomata. They are characterized by pronounced thickening of the vessel-walls, of hyaline appearance, and are frequently of cylindrical form.

The following belong to the angiosarcomata or endotheliomata: cholesteatoma or margaritoma on the venous plexus of the brain of the horse (endothelioma with a deposit of cholesterin crystals), psammomata or sand-tumors of the brain (endothelial tumors with a deposit of carbonate of lime), and xanthomata or xanthelasma (fatty endotheliomata, endothelioma lipomatosum; according to others a form of lipoma).

h) Melanosarcoma or melanoma (pigment sarcoma) is a brown or black, pigmented tumor that is often very malignant; it develops rapidly and is frequently recurrent. It

spreads by metastasis and is most often seen in grey horses, it may, however, occur in dark horses (brown, chestnut, black), as well as in cattle, sheep, and dogs. Histologically melanosarcoma is partly round-celled and alveolar (soft, malignant new-formation), partly spindle-celled or fibrosarcoma (firm, relatively benign tumor). Formerly the pigment was supposed to be the coloring matter of the blood. According to recent investigations, however, the pigment (hippomelanin) frequently contains no iron ; it arises from specific embryonal, pigment-forming cells, the melanocytes (Berdez and Nencki, Lieber). According to Ribbert pigment tumors are formed from the chromatophores. According to Joss the pigment is developed from the albumenous material of the blood through a specific, metabolic activity of the sarcomatous cells (high per cent of sulphur). Melanosis is differentiated from melanoma by pigment infiltration, without tumor formation, in the subcutem, in sheaths of muscles, and in internal organs (calves, cattle, horses).

OCCURRENCE.—Sarcomata are very common in the domestic animals ; they are especially common in cattle, horses, and dogs. Among 54 sarcomata observed by Semmer, 30 were of the dog, 12 of the horse, 4 of cattle, and 2 of swine. Among 643 new formations that I have operated upon in the dog, 44 were sarcomata ; among 200 new formations operated upon in the horse, 50 were sarcomata. From a surgical standpoint the following sarcomata are of importance :

1. SARCOMATA OF THE BONES.—These are partly periosteal, partly central (myelogenous) sarcomata, partly osteosarcomata. They are found in horses and cattle, especially in the nasal cavities and maxillary sinuses, where they may develop from the ethmoid bone, the turbinated bones, the nasal bones, the zygoma, or the superior maxillary bones. They give rise to stenosis, cause chronic catarrh, and may extend into the frontal sinus, the oral cavity, the orbit, the cavities formed by the sphenoid bone, and to other bones of the head. In dogs they are most often found in the oral cavity, and on the superior maxilla, less frequently on the inferior maxilla.

They develop on the gums in the form of proliferations that are nodular, circumscribed, compact, as hard as bone or cartilage, and painless; the surface is rough, irregular, granular, or lobulated; they cause the teeth to become loosened, displaced, raised, and crowded apart (epulis). Central osteosarcomata also occur in horses, dogs, cattle, and swine; they may be solitary or multiple, at times generalized; they occur on the humerus, the scapula, on the femur, on the tibia (lameness), the frontal bone, the petrous portion of the temporal bone (facial paralysis), on the bones of the cranium, neck, and vertebral column. Kammerman saw a case of spindle-celled sarcoma in the cow; it passed through the intervertebral foramen of the atlas to the cervical marrow. Dieckerhoff and Fröhner have observed diffuse myelogenous sarcomata in horses and dogs. A sarcoma of the guttural pouch caused hemiplegia by penetrating the vertebral canal of a horse; another in the same place caused paralysis of the tongue (Hallander). Spinal paralysis is caused in horses, cattle, and dogs by pressure on the spinal cord from hard sarcomata (Dörrwächter, Dexler, and others). In swine a form of so-called snuffle-disease is caused by sarcoma of the facial bones.

2. Lymphosarcoma.—This is most often found in horses and dogs. In horses, according to my experience, they are soft, sometimes fluctuating and cystic tumors. They vary in size from a hen's egg to that of a man's head; they are often multiple, and are found in the intermaxillary region (suspected glanders), in the region of the larynx (goitre-like tumors), on the neck, in the region of the shoulder (a form of shoulder abscess), on the anterior portion of the thorax, in the pelvic glands, on both sides of the sheath, etc. In one case in a horse that was suffering from "intermittent lameness" I found a lymphosarcoma that involved the left iliac and femoral arteries; it was as large as a man's fist. I have also found lymphosarcomata in dogs, especially on the neck and in the region of the pubis; they are often multiple. In cattle lymphosarcomata as large

as one's fist are found in the thoracic region, in the flank, and in the sacral glands (Poncet). Stricker succeeded in transmitting lymphosarcoma of a dog to thirty-one other dogs by means of subcutaneous and intraperitoneal injections.

3. SARCOMATA OF THE SKIN AND MUCOUS MEMBRANES.—These form circumscribed and multiple, or diffuse and extensive tumors of soft or hard consistence. They may appear nodular, lobulated, fungus-like or villous. In cattle and horses they are found in the cervical and shoulder regions; in these places they form extensive tumors which may lead to passive edema or suppuration; they may extend to the thoracic cavity and cause asphyxia from pressure on the trachea; generalization with metastatic formation in the internal organs is common. They also occur in other parts of the body; namely, on the extremities of dogs; on the lips, tongue, rectum, sheath, and fleshy-frog of the horse; on the vulva and vagina of cows (cause of dystocia). Eberlein has described a pendulous sarcoma on the inferior maxilla of a horse. Girotti observed a myxosarcoma on the umbilicus of a calf. Görig has described a multiple sarcoma on the throat and thorax of a hen.

4. SARCOMATA OF THE EYES.—These are most often seen in horses, dogs, and cats. They occur either in the form of a round-celled sarcoma of the orbit where they cause strabismus (squint) and exophthalmos, as well as degeneration of the neighboring bones, and even press into the frontal sinuses, the maxillary sinuses, and the cerebral cavity (Emmerich, personal observations), or a round-celled sarcoma (gliosarcoma) of the retina, or as a melanosarcoma of the choroid (Bayer).

5. SARCOMATA OF THE TESTICLES, UDDER, THYROID AND PAROTID GLANDS.—These result in a circumscribed enlargement, or enlargement of the entire glands, occasionally the enlargement is enormous. According to my experience they are relatively most frequent in displaced testicles, and in the mammae of bitches, as well as in the thyroid glands of the horse. Walley found in a horse (cryptorchid) a round-celled sarcoma of the testicles that weighed 35 kg. I have

likewise diagnosed and removed from two stallions, two small round-celled sarcomata of the testicles as large as a child's head. Schuemacher has observed a similar sarcoma of the testicles in a stallion. Gariuo has described twelve cases of fibrosarcoma of the testicles in breeding animals (eleven were unilaterial, one was bilateral); the testicles were enlarged three or four times their usual size, 2½–3 kg., the spermatic cord was thickened as far as the inguinal ring. Sarcomata also occur in the ovaries and kidneys. Resow described a primary round-celled sarcoma of the udder of a cow.

6. SUBPERITONEAL AND SUBPLEURAL SARCOMATA.—These are apparently common in cattle, horses, and dogs; this is especially true of sarcoma of the abdominal cavity, the pelvic cavity, and the intestines. As a rule they cannot be operated and are of no surgical importance. It is a peculiar fact that many times they cause no obvious external symptoms. They are usually first discovered during a post mortem. In other cases they are the cause of colic (stenosis of the small intestines), and general emaciation, as well as cachexia. Sarcoma of the pelvic cavity may result in an incurable obstruction to parturition; this is due to adhesions, or to compression of the uterus and vagina. Primary or metastatic sarcomata of the lungs, liver, spleen, kidneys, brain, heart, bladder, inner lymph-glands, etc., are of no surgical importance.

7. MELANOSARCOMA.—This is most often seen in horses; it also occurs in asses, oxen, sheep, dogs, and goats; it may be isolated, multiple, or generalized. It is most often seen in old grey horses. They are usually found in the following places: in the vicinity of the anus, the vulva, the vagina, the tail, the sheath and the penis, the shoulder region—especially at the point of attachment of the serratus to the scapula—the eyelids, the lips, as well as the region of the cheeks, the masseters, and the parotid. They may arise in any organ or in any part of the body. They have been found by others in muscles, bones, and lymph-glands. Mauri has described a case of melanoma on the body of the third lumbar

vertebra, which led to pressure of the spinal marrow with a subsequent spinal paralysis. Vache has observed a similar case of pressure atrophy of the lumbar marrow in a seventeen-year-old mare. In other cases compression of the brain, individual cranial nerves (facial), the ischiadicus, and the femoral artery, leads to paralytic conditions. I observed a case of fragilitas ossium (multiple fracture of the pelvis and ribs) in a horse affected with general melanosarcomatosis. In several others, melanosarcoma in the perirectal connective tissue was the cause of chronic colic due to obstruction. Röder observed a case of stenosis of the urethra in a horse caused by melanosarcoma of the pelvis. Many melanosarcomata have a tendency to ulceration and suppuration, so that, for example, cancer-like ulcers are present on the skin, hemorrhage occurs in the nasal cavities (personal observations). Internal melanosarcomata may rupture and terminate in fatal hemorrhages. Generalization is very frequently observed. Metastases develop in the lungs, liver, heart, in the lymph-glands, etc. With reference to the prognosis it may be remarked that in a great number of cases, even in the generalized form, general derangements are not observed. Melanosarcomata are usually of incidental importance in slaughtered horses that are otherwise normal. In St. Petersburg in the years 1892–93, from 7000 slaughtered horses, 36 cases of melanosarcoma, of which 8 were generalized, were observed (Sawaitow). Budnowski found 12 per cent of the First Sovereign Hussar Regiment (only grey horses!) affected with melanoma; in 63 horses the melanomata were from the size of a pea to that of a hazel nut; complications dangerous to life had occurred only four times in the regiment (seat in the pelvic cavity, on the omentum, beneath the vertebral column, in the parotid). In other cases melanomata are very malignant, they undergo ichorous degeneration and chronic hemorrhage; the patient suffers from anemia and general cachexia. The soft, pigmented, round-celled sarcomata have a special tendency to result in the latter course.

TREATMENT.—Sarcomata should be extirpated as early as possible. Treatment is unavailable when metastatic

formation has already commenced. In the latter case especially the prognosis of melanosarcoma is very unfavorable; satisfactory results are obtainable only in solitary, firm, benign melanomata. The various conflicting statements concerning the value of operative treatment for melanomata are explained by the great variations in character of these tumors: benign; very malignant degree of extension. When the removal of the tumor is incomplete, remnants of the sarcoma remain and furnish a source for recurrence. Melanosarcomata are operated exactly like other sarcomata; I have successfully extirpated them in the horse. Delamotte, to prevent recurrence following extirpation with the knife cauterized the wound and then covered it with arsenic; this possesses an affinity for sarcomatous cells (?).

B. EPITHELIAL NEOPLASMS.

I. CARCINOMA.

NATURE.—Carcinoma or cancer is an atypical epithelial neoplasm; it has the property of unlimited growth. All carcinomata are formed essentially of epithelial cells, which lie in a connective-tissue stroma (cancer-stroma) in the form of cancer-plugs, cancer-nests, or cancer-nodules. They proliferate into the neighboring tissues, break down the lymph-vessels and blood-vessels thus leading to metastatic formations. At first the metastasis is confined to the neighboring lymph-glands, afterwards it develops in the form of a generalized carcinomatosis of the internal organs of the body. General derangement of the nutrition thus produced—so-called cancerous cachexia—is due to a form of auto-intoxication, that is, a general chronic poisoning derived from the cancerous new-formation. All carcinomata are derived from epithelial tissues (Thiersch, Waldeyer). Virchow thought that connective-tissue cells were transformed into cancer-cells, this theory has not yet been demonstrated.

FORMS.—According to the different varieties of epithelium (squamous epithelium, cylindrical epithelium, glandular epithelium) the following forms are recognized:

(a) Squamous-celled carcinomata or cancroids are found on the skin, oral mucous membranes, mucous membranes of the pharynx and esophagus, conjunctival mucous membrane, mucous membranes of the vagina and bladder, of the sheath, and of the penis.

(b) Cylindrical-celled cancer is found on the mucous membranes of the stomach, intestines, and uterus.

(c) Glandular-celled cancer develops in the testicles, mammæ, thyroid gland, thymus gland, parotid, prostate, in the sudoriferous and sebaceous glands of the skin, in the mucous glands of the mucous membranes, in the liver, in the pancreas, in the kidneys, and the suprarenal glands.

According to the consistence and form they are classified as follows: hard, firm carcinomata with an abundance of connective tissue (schirrhus, fibrocarcinoma); soft, carcinomata of the consistence of the brain or spinal marrow (medullary cancer, medullary carcinoma); mucous and gelatinous cancer (carcinoma myxomatosum and gelatinosum); pigmented cancer (melanocarcinoma); villous cancer (carcinoma papillomatosum or villosum) and others.

ETIOLOGY.—The origin of carcinomata is no better understood than that of other tumors. A series of etiological factors has been advanced to explain their occurrence in man; the same factors, with nothing added, have found place in veterinary science (see below).

1. Age, sex, nutrition, and heredity are considered predisposing influences for the development of cancer. Experience among men has taught that carcinoma preponderates among those advanced in age. It may develop in any period of life but is seldom seen in a person under forty years old. It is most often seen in people between the ages of forty-five and sixty-five (50 per cent of all cases). In animals (dogs) on a basis of material composed of 262 cases I have observed that old dogs were the only ones

affected with carcinoma ; I have never seen a case of cancer in a dog under two years of age. Of the dogs affected eighty-seven per cent were over five years old, fifty-four per cent were over seven years. Carcinoma forms a contrast to sarcoma ; the latter frequently occurs in young puppies. Similar conditions have been observed in American cattle by Loeb and Jobson ; of the forty-nine cases published all were in cows over six years old. For an explanation of the influence of age on the existence of cancer (diminished resistance of the connective-tissue stroma in contrast to the proliferating epithelial cells) see page 101.

With reference to the influence of sex, it has been maintained that in the human family the increased functional activity of the sexual organs, especially the uterus and mammæ in females, predisposes to carcinomatous disease of these organs. The relation appears to be similar in the dog, where carcinomata of the mammæ are seemingly frequent. This theory cannot be applied to cows, however, where for economic reasons, glandular activity and milk production are most highly developed. Carcinoma of the udder and uterus of the cow has apparently been observed in only a very few cases (up to 1898 I have counted only three cases in the literature ; Guillebeau has recently published records of seventeen cases) although these organs are carefully examined in abbatoirs.

Nourishment exerts an influence on the development of cancer, in that it develops more frequently in those who eat meat than in vegetarians (observations in England). The same comparison has been made in the lower animals ; in the carnivorous animals (cats, dogs) carcinomata are very common ; while in herbivora (cattle, horses) cancers are practically unseen. This theory is valid only in dogs, which, according to my own experience, are the most frequent sufferers from carcinoma. The majority of the neoplasms in the dog belong to this class. On the other hand, the statement that the horse, as a carniverous animal, practically never suffers from cancer is incorrect ; in the years 1895–1902 I operated on twenty-five cases of cancer in the horse. Swine, on the other

hand—omniverous animals that consume flesh—are seldom affected with carcinoma ; this has been demonstrated by experience in the abbatoir. Therefore, for the want of a better cause, it is not so much the nourishment, as the species of the animal that has a predisposing influence on the development of cancer. Concerning the importance of heredity in animals, which by many is considered the principal etiological factor in man (compare with Cohnheim's theory of the scattered embryonic cells, page 100), nothing definite is known. Notwithstanding the fact that carcinomata develop only in old animals, the possibility of heredity among them should not be forgotten. For this reason caution should be employed in the use of breeding animals that suffer from cancer.

2. Traumatic and chemical irritation have recently been placed in the foreground as etiological factors for the production of cancer in man. This theory is supported by the appearance of cancer in the following places : the so-called cicatricial cancer which develops in a cicatrix under the influence of a chronic inflammation ; the frequency of cancer of the gall-bladder when under the influence of mechanical irritation from gall-stones ; the appearance of cancer on the lips, tongue, and larynx of tobacco-smokers ; as well as upon the skin of chimney-sweeps, workers in tar, paraffine, etc. According to Brosch continual irritation of granulating cutaneous wounds with xylol developed artificial proliferations of the epithelium in guinea-pigs ; it was alleged that these could not be differentiated from incipient carcinomata of the skin (?). According to M'Fadyean cancer of the skin occurs in Australian cattle after branding (!?). According to Eggeling cutaneous cancer of the inferior maxilla occurs in swine in an enzootic form as a result of feeding from troughs (?).

Cancer has not yet been experimentally produced by the influence of continued mechanical or chemical irritants, for example, applications of tar to dogs and rats (Hanau). Probably the irritants are only able to cause cancer when there exists a primary local or general predisposition ; they are not essential etiological factors, but exert an accessory influence. The fact should also be noted that carcinomata frequently de-

velop in organs that are protected against external irritation (prostate and thyroid gland of the dog, cavities of the head, thoracic cavity, abdominal cavity in the horse). The theory that cancer of the lips and tongue of animals frequently develops from external iritants is also wrong from a veterinary standpoint. On the contrary, they are very seldom produced in his manner. I have seen only one case, and have found only two cases mentioned in literature.

3. Parasitic infection has in recent years been frequently considered a cause of cancer. The parasitic nature of cancer has not yet been satisfactorily demonstrated; its existence is improbable. Bacteria have also been credited as the cause of cancer (cancer-bacillus of Scheuerlen); so far they have all proved to be inocuous accidental saprophytes (proteus mirabilis). The cancer-bacillus recently described by Schuller has proved to be a contamination of the preparation with cork-cells. Also the protozoa or coccidia, which, according to Pfeiffer, Thoma, Adamkiewicz, v. Leyden, and others, existed in a special form within the cancer-cells, have proved to be degenerated forms of epithelial cells, as well as degenerated nuclei and nuclear bodies. The following conditions when examined under the microscope may be confused with coccidia: endogenous new-formations of cells; incomplete cellular division; invagination of individual cells into each other; the presence of red and white blood-corpuscles in cells; pathological nuclear division; mucous, colloid, hyaline, and vacuolar degenerations of the cell-protoplasm, pathological cornification; degenerations of the nucleus, the nuclear bodies, and the nuclear membrane.

Metastasis, which is common in cancer, as well as an occasional successful artificial transplantation of the cancer in both men and animals (Hanau, Geissler, Hahn, v. Bergmann, Wehr, Cornil, Jensen) are cited as examples of the parasitic nature of the cancerous neoplasm. In contrast to the few successful cases mentioned

are the unsuccessful attempts at transmission of many other investigators (Klebs, Tillman, Israel, Shattock and Ballance, Alberts, Pütz, Trasbot, Duplay, Cazin, Cadiot, Gilbert, Gratia, Lièn-aux, English Cancer Commission, and others), the parasitic nature is in no way proved by the artificial transmission of cancer. The successful results of inoculations are in reality nothing more than transplantations, or artificial metastatic formations; the specific pathological epithelial cells have been transplanted, not the parasite of carcinoma, the new cancer-proliferation develops from these cells. It has also occurred that, in inoculation experiments carried on in man, self-infection has taken place in those already affected. In these cases the principal factor, a predisposition, was present.

CANCER IN MICE.—Jensen (Experimentelle Untersuchungen über Krebs bei Mäusen. Zentralblatt für Bakteriologie, 1903, Bd. XXXIV, S. 28) has recently transmitted a carcinomatous tumor in a mouse over nineteen generations of white and grey mice (not, however, to other animals). The transmission was a simple transplantation. Mere crushing of the cells of the tumor produced negative results. Proof of the parasitic nature of the carcinoma could not be found. On the other hand, therapeutic experiments with blood-serum from vaccinated rabbits produced good results in diseased mice. The preparation of a serum to produce immunity is very difficult; the results are also uncertain. Jensen, at least, thought that there was no basis for the introduction of hope from the serum-treatment of cancer in man.

PSEUDO-CARCINOMA.—Zschokke has observed two cases of a cancer-like tumor on the upper lips and intermaxillary space in horses; it was caused by a fibrillar fungus (actinophytosis), and was as large as one's fist (Schweizer Archiv. 1903). It consisted of a connective-tissue stroma with compartment-like enclosures (carcinomatous structure), these contained foci of leucocytes, and peculiar fungiform structures with filiform processes (degenerated filimentary fungi). In all probability the infection occurred from without through wounds and epithelial defects in the oral mucous membrane. The fungus resembled the actinomyces fungus, it varied from it, however, in certain respects.

OCCURRENCE.—Localization of cancer is different in animals than in men. Horses and dogs are the only animals of essential importance; in cattle, sheep, goats, swine and

cats, carcinomata are only occasionally of surgical importance. The following are the most important special forms:

1. CARCINOMA OF THE SKIN.—This is most often found in dogs; according to my experience it most frequently occurs in the following places: on the head (ears and eyelids), on the back, on the tail, on the prepuce, scrotum, in the vicinity of the anus and on the limbs. In the horse the favorite places for the development of cancer appear to be on the glans penis, the vulva and clitoris, on the tail and sheath, as well as in the region of the bulbs of the foot. Carcinomata of the penis form tuft-like, villous, often suppurative tumors; they usually attack the prepuce and lead to metastases in the inguinal glands (Leisering, Möller, personal observations). Macroscopic appearance of carcinoma is extremely variable according to the age and location of the tumor. Carcinomata of the skin usually present the following appearance: they are attached to the skin, have a tendency to ulceration and infiltration of the adjacent tissues, and are firm in consistence; the surface is nodular and rough; the margins of the ulcers are wall-like and firm; nodular formation is present in the vicinity; there is a secondary swelling of the neighboring lymph-glands. The neoplasms may be circumscribed or diffuse; large areas of the skin may become ulcerative, nodular, thick, lardaceous, ichorous, and transformed into immense tumor-masses that are foul in appearance and odor. On the penis, carcinomata form tumors that are papillomatous, villous, fissured, and often very large.

2. CARCINOMA OF THE MUCOUS MEMBRANES.—These are often found in superior maxillary sinuses of the horse. According to my observations they form firm, lobulated, hemorrhagic, very rapidly developing tumors. The neoplasms are permeated with hemorrhagic foci and contain a fluid similar to that found in the medullary substance of the brain; they usually arise from the mucous membranes of the oral and pharyngeal cavities (squamous-celled cancer

of the hard gums) and lead to loosening of the teeth, penetration to the nasal cavities, maxillary sinuses, and even the frontal sinus, they also result in swelling of the intermaxillary lymph-glands (metastatic formation). Similar tumors have been observed in the nasal cavities of the horse; in this case the squamous-celled cancer originated from the squamous epithelium of the lachrymal duct (Montfallett). Carcinomata are further found in the pharyngeal cavity of the dog, as well as in the turbinated bones and esophagus of the horse. In the latter place, under certain conditions, they may lead to perforation and fatal pleuritis; a case of this kind has been described by Lorenz. Carcinomata are further observed on the mucous membranes of the eyes in horses; they either involve simply the membrana nictatans (personal observations), or the conjunctival schlera (Bayer), or penetrate the entire orbit destroying the neighboring bones, especially the frontal bone, the superior maxillary bone, the zygoma, and the lachrymal bone, even penetrating into the frontal and superior maxillary sinuses (Leisering, Möller, Eichler, personal observations). Among two and one half million cattle slaughtered in Chicago in 1899 Loeb and Jobson claim to have found forty-eight cases of squamous-celled cancer of the lachrymal caruncle (at first it is about the thickness of one's finger and papillomatous; it afterwards becomes extensive, fissured, and covered with blood-coagulum.

Carcinomata are also frequently found in the vagina, on the clitoris (Eberlein, Hennig, Naudin), in the uterus (Guillebeau), in the bladder, as well as on the skin and mucous membranes of the prepuce of dogs, horses and cattle. Olt has described a case of cancer of the rectum in the horse (squamous-celled cancer, congenital wandering of squamous epithelium to the mucous membrane of the rectum). Carcinomata of the bladder are usually in the form of villiform cancers; they present cauliflower-like, villous, tufted, fissured proliferations of the consistence of mucus, and have a firm base. They lead to hemorrhage and ichorous degenerations,

as well as to nodular formations in their immediate vicinity (hemorrhagic, ichorous, fetid, sedimentous urine); occasionally they extend to the peritoneum and the abdominal viscera, or result in a fatal perforating peritonitis (Siedamgrotzky, Kitt, Pflug, Esser, Bang, Demeurisse, Bollinger, and others). A case of cancer of the tongue has been observed in a twelve-year-old cat (M'Fadyean); he found a cancerous ulcer on the ventral surface of the tongue, from here plug-like carcinomatous proliferations penetrated the entire tongue. Pflug and Leblanc have described a case of cancer of the tongue in cattle, and cancer of the lips in a dog. In the larynx (epiglottis) only one carcinoma has been observed (Casper). Cancer of the stomach is far less common in animals than in man; veterinary literature contains records of only a very few cases in the horse and dog (Oltmann, Roloff, Kitt, Eberlein, Dürbeck).

3. Carcinomata of Glands.—These are most frequently observed in the mammæ of the bitch; I have operated eighteen cases. Their consistence and size are extremely variable; pain and heat are usually absent; the skin is either intact, or possesses ulcerative foci and undergoes cancerous infiltration; the adjacent lymph-glands are frequently swollen. Carcinomata of the mammæ are sometimes soft, and may even fluctuate as a result of cystic degeneration. Many cases have been observed by Bang, Kitt, Rabe, Johne, Möller, Pütz, Pflug, Stenzel, and others. In cattle, horses, and swine, on the other hand, cancers of the mammæ seldom occur (Cadiot).

Carcinomata of the testicles are common in horses and dogs; they often result in a marked enlargement of the testicles (one form of so-called sarcocele), infiltration of the spermatic cord, swelling of the inguinal glands, carcinomatosis of the peritoneum, as well as metastatic formation; they are occasionally observed in cryptorchids, and are not uncommon in the laterally displaced testicles of the dog. Cases of cancer of the testicles have been described by Leisering, Stockfleth, Röll, Guillebeau, Siedamgrotzky, Möller, Fröhner, Trasbot, Cadiot, and others.

Carcinoma of the thyroid gland occurs most frequently in horses and dogs; it occurs in the form of goitre (struma maligna, struma carcinomatosa). It is characterized by rapid development, emaciation and cachexia of the animal, as well as metastatic formations in the lungs (breaking down of the jugular) and other internal organs, followed by a fatal termination (Johne, Kitt, Siedamgrotzky, Möller, Zschokke, Hutyra, Cadiot, personal observations). In dogs thyroid-gland cancers may reach the size of two fists; in horses they may attain twice the size of a man's head. They often embrace the trachea and esophagus, and occasionally extend as far as the thoracic cavity.

Cancer of the prostate in dogs is of special importance as it can be diagnosed per rectum, it often forms a tumor as large as one's fist, and is the cause of habitual constipation (personal observations). Only one case of cancer of the prostate in the horse has been described (Cadiot). Carcinomata of the anus are very common in dogs; they originate from the anal glands (compared with these, carcinomata of the rectum are very rare). They form uneven, nodular, warty, cauliflower or fungus-like neoplasms; they are fissured and lobulated; occasionally they are also pedunculated, soft, and painless.

Siedamgrotzky has described a cancerous neoplasm that originated in the thymus gland of the horse; it led to metastatic formation in the inferior cervical glands, the principal lymph-vessels, and the retro-pharyngeal and submaxillary lpmph-glands, as well as to extensive schlerosis of the subcutaneous and intermuscular connective tissue. It presented the clinical appearance of a high-grade edema of the skin on the dependent portions of the head, neck, and thorax.

Hinrichsen observed a multiple cancer of the lymph-glands of the head (medullary carcinoma) in two horses, it was characterized by metastases in the internal organs, in the glands in the vicinity of the shoulder and arm, and the axillary glands; pronounced edema was also present in the same vicinity. Similar cases of primary cancers of the

lymph-glands in horses and dogs have been described by Leisering, Casper, Kitt, and Fröhner. Petit has observed one case of carcinoma of the parotid in the cat.

4. CARCINOMA OF THE INTERNAL ORGANS.—They often occur in horses, dogs, and cattle, but are of trivial surgical importance. They are often found on the pleura, on the peritoneum, in the omentum, and in the mediastinal, mesenteric, and lumbar lymph-glands, where they are often multiple, characterized by secondary metastases, and more or less generalized. Enormous masses of tumors are often formed, they involve the lungs and other adjacent viscera, and even penetrate the walls of the thoracic and abdominal cavities. Carcinomata have also been observed in the liver, in the kidneys, in the suprarenal glands, in the ovaries (10 to 20 kg. in weight, occasionally fatal through hemorrhage and peritonitis), in the rumen, stomach, intestines, in the lungs, in the brain, and spinal marrow (metastases). A cancerous metastasis in the horse has led to pressure-paralysis of the spinal cord (Alfort Clinic).

TREATMENT.—As in sarcomata, so in carcinomata, the earliest possible extirpation forms the basis for successful treatment. Caustics are rarely indicated. Operative removal of the following forms is relatively simple: carcinomata of the skin and anus, as well as carcinomata of the membrana nictitans and eyelids. Carcinomata of the mammæ, penis, and testicles are removed by amputation, or castration. It is more difficult to treat proliferating carcinomata in the cavities of the head (trepanation). Extirpation of cancer of the thyroid gland is especially difficult (severe hemorrhage, cachexia strumapriva). All internal carcinomata are incurable (pleura, peritoneum, lungs, internal lymph-glands, liver, kidneys, bladder, stomach, intestines, etc.); the same is true of generalized carcinomatosis. Arsenic, which was formerly administered as an internal specific, acts only as a stimulant to metabolism and nourishment. Inoculation of the cancer with erysipelas has occasionally been followed by recovery in man, it is seldom employed at the pres-

ent time as it endangers the life of the patient. Serum-theraphy (injection of blood-serum from animals affected with cancer, or from animals into which masses of cancer have been inoculated) has not proved a success (Cadiot, and others). This serum seems to possess a specific action for experimental animals (mice) (Jensen). Recently, Röntgen rays and radium rays have been employed to cure cancer (this method results only in the destruction of the cancer-cells).

STATISTICS OF CANCER IN ANIMALS.—Sticker has collected reports from veterinary literature on 1217 cases of cancer (332 horses, 766 dogs, 78 cattle, 21 cats, 12 swine, 8 sheep and goats). According to frequency they were arranged as follows:

1. Horse: penis, nasal and adjacent cavities (52 cases), kidneys (29), skin (22), vagina (18), eyes and urinary bladder (14), lungs and testicles (13), gingivæ (11), anus, stomach, thyroid gland, uterus (8), larynx (7), etc.
2. Cattle: uterus (16), kidneys (10), bladder (9), ovaries and stomach (6), liver (4), vagina and lungs (3), etc.
3. Dog: mammæ (341), skin (166), anus (89), thyroid gland and lungs (10).
4. Cat: skin (6). mammæ (5), lungs (3), liver (2).
5. Swine: kidneys (7), skin (2).

II. PAPILLOMA.

NATURE AND FORMS.—Papilloma was formerly considered a connective-tissue proliferation of the papillary body, and classified with the fibromata (papillary fibroma); recently it has been placed with the epithelial neoplasms (papillary epithelioma) and is considered a mixed tumor (fibro-epithelial neoplasm). It consists of a hyperplasia of the epithelium of the skin and mucous membranes with a simultaneous proliferation of the papillary body (connective-tissue and vascular new-formation). Two forms of papillomata are recognized:

a) Warts (verruca) are hard, dry, horny papillomata derived from the epithelium of the skin.

b) Condyloma (fig-wart) is a soft non-cornified, vascular

proliferating papilloma of the skin and mucous membrane (pointed, broad condyloma); it is moist on the surface (fig-wart, moist wart), and has the appearance of cauliflower or cockscomb.

ETIOLOGY.—Chronic inflammatory irritants play an important part in the development of papillomata. The so-called verrucose form of scratches in the horse is a multiple warty formation on the skin of the fetlock; it is the product of a chronic dermatitis or infectious inflammation of the skin. They have also been seen on the lips of horses and cattle that have been pastured in fields of stubble; such cases are due to inflammatory processes on the skin and mucous membranes. Chronic irritants (excretions) in the vicinity of the vulva and anus may also be considered occasional causes of papillomatous neoplasms. Some believe that papillomatous tumors are contagious. Mégnin described alleged infectious papillomata on the lips of lambs in which he demonstrated spherical pathological microörganisms. M'Fadyean and Hobday have successfully transmitted papillomata from one dog to another. Aubert and others have observed transmission from cows to men. The inoculation experiments of Gratia, on the other hand, were unsuccessful.

In addition to the irritation theory, the question of heredity as an etiological factor in the production of papillomata must be considered. It has been observed that in foals, calves, and dogs, papillomata are congenital. Many believe in hereditary transmission. In these cases inflammation is excluded as an etiological factor; the basis of the cause must lie in an embryonic proliferation of the cells.

OCCURRENCE.—Papillomata are most often found in dogs, horses, and cattle.

1. In dogs, the favorite locations for development are the lips, the mucous membranes of the mouth (lips, gingivæ, tongue), the eyelids, the ears, especially the external auditory canal, the buccal region, prepuce, penis, the anus and vagina, as well as the extremities. Papillomata are characterized by their rough and lobulated surface; they are similar in appearance to strawberries, rasp-

berries, blackberries, cauliflower, cockscomb, etc. They usually have a sharply defined margin, occasionally they are pedunculated; they vary in size from a lentil-seed to that of a pea or a walnut; they may be dry or moist on the surface. General papillomatosis is common.

2. In cattle papillomata are often multiple so that the entire skin appears to be covered with warts. They are especially numerous on the head, throat, on the shoulders, udder, abdomen, on the penis, and on the limbs. They form rough, granulation-like, lobulated, painless neoplasms; they are often fissured, and are broad or pedunculated; they are firm in consistence, and yellowish-white in color, they become confluent and attain the size of a man's fist, sometimes even that of a man's head. Papillomata are extremely variable in form; at times they lead to an extensive thickening of the skin, and they may attain a weight of fifty pounds. Thierfelder observed a papillomatous tumor that extended from the withers to the root of the tail in a three-year-old heifer; it was from 30 to 40 centimeters broad and 15 to 20 centimeters thick; from a distance it had the appearance of the horny covering of an immense tortoise; nearby it was similar in appearance to the quills of a porcupine. Wehrner has described a case of papillomatosis with a mane-like covering of hair (hypertrichosis) on the neck. In many cases the udder is the seat of numerous papillomata; the dry form is especially common on the teats, occasionally the teats are the seat of soft, villiform warts. In addition to these cutaneous papillomata, others are frequently observed on the mucous membrane of the pharynx and esophagus, occasionally they are seen in the omentum and bladder. In lambs, warts are very often found on the lips.

3. In the horse, especially in foals, warty growths are found in the region of the lips, the nose, on the eye-lids, ears, on the sheath, etc. In older horses they are found on the following places: in the region of the saddle and harness, on the coronet (personal observations), as well as subsequent to scratches on the fetlock (dermatitis verrucosa so-called "Straubfuss" bristle-foot). They are

very rare in the bladder where they form one variety of so-called villiform cancer. Canker of the hoof (canker of the frog) is a papillomatous neoplasm; it is characterized by pronounced proliferation of the papillary body and rete mucosum; in this disease the growth of the horn is suspended (infection?).

TREATMENT.—Treatment of papillomata consists in simply cutting away with scissors, or twisting off with the fingers. Caustics (concentrated nitric acid and other acids) are not indicated, with the exception of papillomatosis of the frog; in any case they should be applied with great caution in the vicinity of the eyes and mouth. Papillomata on the lids, because of the possibility of transformation, must be thoroughly treated, that is, extirpate the entire tumor by removing a keel-shaped section of the lid. In young animals, the internal administration of arsenic has occasionally been followed by good results. Papillomata often disappear without treatment. Spontaneous healing of cancer of the frog has occasionally been observed after recovery from contagious pleuropneumonia.

III. ADENOMA.

NATURE.—An adenoma is a non-cancerous, benign, epithelial neoplasm of glandular type. Adenomata are termed tubular, acinous, or alveolar, according to the type of the gland from which they are derived; they are also classified according to the nature of the gland, adenoma of the thyroid gland (struma), mammary, hepatic, sudoriferous and sebaceous adenomata. When an adenoma consists largely of connective tissue it is termed a fibroadenoma; when the converse is true it is termed an adenofibroma (so-called fibroepithelial neoplasms). Adenomata, regardless of their benignity as epithelial neoplasms, occasionally have a tendency towards carcinomatous transformation (malignant adenoma, adenoid).

OCCURRENCE.—It is most frequently seen, especially in

puppies, in the form of goitre (simple hyperplastic struma)—adenoma of the thyroid glands—it is less common in the horse (Lanzillotti, Markus, Pfeiffer, personal observations). Adenofibromata of the nasal mucous membranes are relatively frequent in horses (firm, rough, multiple, readily hemorrhagic, usually bilateral neoplasms on the lower third of the nasal mucous membranes; formerly they were erroneously termed rhinoschleroma). Adenomata are not rare in the mammae of the bitch. Only a portion of these neoplasms, however, are pure adenomata, they are frequently fibroadenomata, adenofibromata and myxoadenomata (Leblanc). An adenoma of the mucous membranes of the larynx has been observed in a cow by Johne; sebaceous adenomata and sudoriferous adenomata have been observed in the skin of dogs, especially in the vicinity of the anus (perineal glands) (Kitt, Siedamgrotzky, Möller, and others). Adenomata of the Harderian glands of the membrana nictatans have been observed in the dog by Schimmel and myself. Adenomata also occur in the rectal mucous membranes (glands of Lieberkühn) of horses in the form of cysts and polypi (personal observations). Adenomata of the liver, as well as of other inner organs, are of no surgical importance.

EPITHELIOMA.—In Germany this term is applied to a benign, circumscribed neoplasm of the epidermis on the skin (in France, epithelioma indicates a carcinoma). It is partly due to continual irritation of the skin by pressure (callosities, clavus, tyloma), partly caused by parasitic infection (epithelioma gregarinosum or molluscum, bird-pox).

CORNU CUTANEUM.—This is an epithelial neoplasm similar to epithelioma (cornu cutaneum, keratosis, keratoma). It is a circumscribed outgrowth of newly-formed, horny, epidermal cells. They are often found in cattle on the neck, in the intermaxillary space, on the head, on the abdomen and udder; occasionally they occur in the form of horn-like structures one-fourth to one-half meter in length; at times they are of actinomycotic origin (Schreiber); they may also occur in birds as a symptom of tuberculosis of the skin (Eberlein has described a typical case in a parrot), they are found in horses (fetlock, ear), sheep, dogs, and goats.—KERATOMATA (tumor-like, usually, however, inflammatory hyperplasias of the hoof-horn) are similar proliferations; the same is true of onychoma (hypertrophy of the

tissue of the nail), ichthyosis (congenital or horn-like thickening of the entire skin, especially in calves), as well as hystriciasis (congenital bristle-like erection of the hair and thickening of the skin).

CYSTOMATA.—These are epithelial neoplasms in glands, with cystic formation. They may be defined as cystic adenomata. They are most often found in the ovaries (ovarian cysts), in the thyroid gland (cystic goitre), in the mammæ, parotid, and in the superior maxilla of the horse. In contrast to ordinary cysts, cystomata are genuine, proliferating cysts (see page 150).

C. CYSTIC TUMORS.

DEFINITION.—A cyst is a sac-like, spherical, or bladder-like tumor; it contains fluid and is surrounded by a capsule. The development of cysts is extremely variable. The following forms are recognized.

1. Retention-cysts.
2. Dermoid cysts.
3. Genuine cysts (cystoma).
4. Extravasation- and exudation-cysts.
5. Cystic degeneration.

RETENTION-CYST.—A retention-cyst is formed by a retention of the secretions of a gland. Various types of retention-cysts are recognized.

a) So-called mucous cysts develop from the mucous membranes as a result of retention of the secretions of the mucous glands. They are especially common in the oral cavities of dogs, cattle, and horses; they are situated at the lateral and ventral surfaces of the tongue in the form of so-called ranulae (retention-cyst of the sub-lingual gland; according to others a dermoid cyst); in the intermaxillary region and region of the larynx in the form of so-called meliceris; on the mucous membranes of the lips, especially on the upper lip in the horse; in the nasal cavities; at the base of the epiglottis; and in the trachea of horses and cattle. They are found in the vestibule of the vagina in cows (retention-cysts of both glands of Bartholin, or of Gärtner's duct),

as well as in the rectum in horses (glands of Lieberkühn).

b) So-called atheromata (pultaceous cysts, encysted tumors) occur in the skin, especially that of horses (base of the false nostril, inner canthus of the eye, base of the auricular cartilage), swine (teats), and dogs (back); they are usually solitary. Multiple atheromata are rare (Velmelage has described a case in the dog). Formerly they were all considered retention-cysts of the sebaceous glands. Recent investigations have demonstrated that they are partly due to aberration of epidermal cells, such cases must be classified with dermoid cysts.

c) Retention-cysts of large glands, especially the udders of milch cows are due to an obliteration of an individual milk-duct, or the common milk-canal.

DERMOID CYSTS.—This name indicates neoplasms which belong to the teratomata. They are due to an embryonic wandering of germ-cells of the skin or mucous membranes; these may pass into the inner organs (subcutis, ovaries, testicles, brain), so that, under certain conditions, the walls of the cyst contain all the different elements of the skin or mucous membrane, namely, epidermis, papillary body, hair and feathers, sebaceous, sudoriferous, and mucous glands. To this class belong the so-called tooth-follicle cysts; these occur in horses and cattle in the vicinity of the parotid glands(so-called ear-fistula); they are branchial-arch teratomata, that is, derivatives of a primative tooth-fold of the epithelium of the oral cavity, they are a result of the presence of the branchial arches. One usually finds a small opening at the base of the ear, the surrounding hairs are matted by a tenacious, slimy fluid; on passing a probe it enters a blind canal or cystic hollow space, at the bottom of which a molar tooth is found. About one hundred cases of branchial-arch teratomata in horses and cattle have been recorded. Dermoid cysts also include the very rare tooth-teratomata on the superior and inferior maxilla of the horse; these are large tumors which contain hundreds of teeth in all stages of development (Ostertag, Lohoof). By many, ranula is considered a dermoid cyst. Dermoid cysts of the ovaries are very rare (hair, teeth, bones).

GENUINE CYSTS.—Genuine cysts are also termed cystomata; they are glandular, epithelial neoplasms (cystoadenoma) (see page 148). They are most often found in the ovaries and in the thyroid glands. They are the ordinary cystic formation (single sac, or multiple hollow spaces) in the ovaries of cattle, horses, and dogs; occasionally they become very large. Stockfleth has observed a cystic ovary that weighed 125 pounds, in a cow; Albrecht has observed one that weighed 80, and another that weighed 50 pounds in the horse. I observed a case in which a cystic ovary as large as a child's head constricted the rectum and caused fatal colic in a mare. Finally, genuine cysts occur in the superior maxilla of the horse (detached epithelial foci); occasionally they press through the superior maxillary sinuses into the nasal cavity (pseudo-hydrops of the maxillary sinus).

EXTRAVASATION- AND EXUDATION-CYSTS.—Hematomata due to contusions may become encapsuled as a result of aseptic inflammatory processes in their vicinity; they form swellings having a cavity filled with serum, and are termed extravasation-cysts or blood-cysts. They are frequently observed on the anterior surface of the carpal-joint in cattle (so-called knee-boils), and on the neck and back of the dog. Their existence is analogous to capsule formation around foreign bodies and parasites (foreign-body cysts, parasitic cysts). Blood- and lymph-cysts, the result of gradual dilitation of blood- and lymph-vessels (dilitation-cysts), are less common. Exudation-cysts are formed in a similar manner as a result of inflammation of mucous membranes and tendon-sheaths. To this class belong hygromata of the mucous bursae over the point of the elbow (so called shoe-boil) and os calcis (so-called capped-hock) in horses and dogs, as well as hygroma proliferum on the carpus of the horse and ox (one form of knee-boil).

DEGENERATED CYSTS.—These are cystic degenerated neoplasms (cystoid degenerations); they most often occur in sarcomata and in carcinomata (cystosarcoma, cystocarcinoma, cystofibroma).

TREATMENT.—Treatment of cysts consists in extirpation of the sac. Simple puncture or incision is usually insufficient; this is especially true of mucous cysts and atheromata. On the other hand, puncture with a subsequent injection of tincture of iodine is effectual in many forms of extravasation- and exudation-cysts (hygroma, shoe-boil); it is necessary to incise and remove the necrotic sac. When removing the sac care should be taken to remove all the parts; no portion of the proliferating tissue should remain behind. Special difficulty is encountered in the total extirpation of ranula; this is also true of many mucous cysts in the throat of the dog. On the other hand, teratomata are usually operated without difficulty. In tooth-follicle cysts the teeth are removed from the temporal bone with hammer and chisel, and the mucous membrane of the cystic sac is carefully curetted. Cysts of the ovaries in cattle may be crushed per rectum with the hand.

D. INFECTIOUS TUMORS.

I. ACTINOMYCOMA.

ETIOLOGY AND PATHOGENESIS.—Actinomycoma is a swelling caused by the ray-fungus or actinomyces. This fungus, which belongs to the schizomycetes (cladothrix), was described by Perroncito, Rivolta, Hahn, and Bollinger in the years 1868–1877. Macroscopically it forms sulphur-yellow, sand-like kernels. Under the microscope they have the appearance of glands, with a branching, rosette-like arrangement, composed of club-shaped, thick threads. Entrance of the actinomyces fungus into the body seems to occur in various ways. It usually gains entrance through the digestive tract (mouth cavity, pharynx, stomach, intestines). Their primary seat is on the fragments of plants; they have been especially demonstrated on beards of grain, in the tonsils of swine, and in the tongues of cattle. It is thought that transmission occurs as

follows: at first the fungus gains entrance to small wounds of the mucous membranes, or passes into the excretory ducts of glands, possibly it colonizes in the alveoli of diseased teeth, or those that are changing; its further extension is from these points. In cattle, especially, beards of grain covered with fungi appear to penetrate between the teeth and gums, as well as into the tongue. When they once gain entrance removal is difficult because of the peculiar arrangement of the hairs on the beards; a similar phenomenon is observed with rye-beards, for example, when they become attached to one's coat-sleeve. A favorite location for actinomycosis of the tongue is on the dorsal surface where it begins to form the point. Epithelial defects are present at this point in many cattle (9 per cent), thus favoring the introduction of an actinomycotic infection (Hentschel and Falk). According to Breuer the folds of the dorsal surface, especially in old cattle, where they are well developed, predispose to the retention of fungus-covered vegetable fibers. Boström thought that the ray-fungus developed exclusively on grain, especially in barley, and that actinomycosis could be caused only by ingestion of portions of these infected plants. Symmetrically arranged air-spaces are found in dry grain-beards, these communicate freely with the surface; within these spaces the fungus is able to live in a dried condition for more than a year; when the beards gain entrance to animal tissue proliferation is again active. Dry fodder, therefore, appears to be the principal source of infection in cattle; perhaps simultaneous shedding of the teeth also has an influence (Immiger, Claus). Entrance to the lungs may take place by aspiration of the fungus from the air; wounds of the skin, especially castration wounds and umbilical wounds allow entrance; it may also enter through the openings in the teats. In swine, infection of the snout from the straw seems to be frequent. In a large number of cattle treated with setons a majority of the wounds showed actinomycotic infection (Gooch). General extension (generalization) over the entire body by means of the blood-stream

also occurs, similar to tuberculosis, though far less frequently. With reference to the rapidity of growth of actinomycoma, the following observation has been made by Anderson: twenty cows were turned to pasture on the first of July; small and large tumors had developed on seventeen by the first of December (five months).

Actinomycosis is a specific inflammation; domestic animals are affected with three grades of the disease: 1. A degenerative granulo-fibrous inflammation (tongue). 2. A progressive purulo-granular inflammation (cold abscess). 3. Fungoid actinomycoma (pharynx, skin). In the vicinity of glands in which the fungus is active, there first develops a granulation-like growth, the result of a reactive inflammatory process. This leads to the formation of tubercle-like nodules, larger round or lobulated swellings, and tumors, which are termed actinomycomata. Sometimes they are very soft, of a sarcomatous consistence, and yellowish-red in color; others are apparently firm and solid, of the consistence of a fibroma, and greyish-white in color; occasionally they are spongy. They consist of a connective-tissue stroma permeated with many nodules the size of a millet-seed to that of a pea; on the surface of the swelling these nodules present a shiny appearance. The nodules have the microscopic structure of a granuloma (round-celled infiltration with the formation of giant-cells), they contain the sulphur-yellow, sand-like actinomyces fungi, they may also become confluent and form larger nodules. In purulent degeneration of actinomycoma (mixed infection with pus-bacteria) so-called cold abscesses are formed, these may be small or large and are surrounded by very soft granulation-tissue.

BACTERIOLOGY.—According to Boström, pure cultures of actinomyces are best obtained by pulverization of the gland, and cultivation upon coagulated blood-serum. They present the following characteristics: first there are developed thin, gelatinous membranes, they are formed of fine, transparent threads, and through a deposit of small white particles containing numberless cocci and fibrillæ they assume an appearance of having been dusted with chalk. After two weeks the centers of the white particles become yellowish, red, or brick-red, the particles themselves become confluent; the periphery grows

in the form of a transparent greyish-white layer. Old cultures become wrinkled and hard. The fungus grows in a similar manner on agar, glycerin-agar, and gelatine; on potatoes it forms grey, yellowish, and finally white granules. It also grows in the absence of air (facultative anærobic fungi). Inoculation of the cultures into animals is not usually followed by results. Wolff, Israël, and Johne are the only ones that have developed inoculation-actinomycosis from cultures.

According to recent investigations actinomycosis occurs in several varieties in both men and animals. Gasperini was the first to demonstrate that actinomycosis in cattle could be produced by various varieties of the fungus (sulfurens, albus, luteo-roseus). According to Lignières and Spitz in Argentina there occurs an actinobacillosis in addition to genuine actinomycosis. The bacillus does not take Gram's stain; clinically it is characterized by disease of the lymph-glands (which is seldom seen in the genuine form), and a grayish-white color of the glands (in contrast to the yellow). Jelenewski has discovered a specific "Actinomyces labiatus bovis" in actinomycoma of the lips. Levy, Bruns, and others have further claimed that several varieties occur in man (ærobic and anærobic), and that actinomyces bovis and hominis, especially, are not identical. According to Wolff and Israël, however, the acceptance of various ray-fungi is incorrect; they explain the difference in size, etc., by variations in age, and the duration of the disease.

Occurrence.—One most frequently finds actinomycoma in cattle in the mucous membranes of the mouth and pharynx, in the tongue, in the maxillary bones, in the skin, in the parotid glands, and in the udder. Occasionally actinomycosis appears in a generalized form. The disease is most frequent in cattle; horses, swine, and sheep are occasionally affected; it is less frequent in cats and dogs.

Actinomycoma of the Tongue.—In the tongue actinomycosis is usually multiple and disseminated; connective-tissue proliferation is abundant (indurative, and actinomycotic glossitis, actinomycotic sclerosis or macroglossia, so-called wooden-tongue). The tongue is very much enlarged and deformed, occasionally it is shapelessly swollen, and of a very firm, hard consistence. On the mucous membranes of the inferior and lateral surfaces one observes sharply circumscribed, somewhat prominent brownish spots, spherical in form;

through these there shine very small yellowish nodules. Actinomycotic nodules are also present in great numbers within and beneath the mucous membranes, as well as between the muscular fibers, they are firm, fibrous, roundish nodules, and vary in size from a millet-seed to that of a pea; in the center they consist of a suppurative, caseous, calcified, or mortar-like mass. When cut the indurated connective tissue of the tongue is found to be lardaceous, hard, and even crepitating. The lymph-glands of the tongue also contain the above described nodules, as well as abscesses in the form of yellow, sand-like, antinomycotic foci containing pus. Actinomycotic erosions are also occasionally found on the dorsal surface of the tongue, they form epithelial defects where the body of the tongue passes over into the point. Brownish actinomycotic nodules occur on the gingivae as well as on the inner surface of the lips (Klepzow). On the ventral surface of the oral cavity actinomycotic proliferations of the mucous membranes occasionally present the appearance of a ranula (Hohenleiter). A few cases of actinomycosis of the tongue have been observed in the horse (Truelsen, Gruber, Zschokke, Novotny, Struve, and others). Schilling has described one case in swine.

Actinomycosis of the Maxillary Bones.—Actinomycotic ostitis of the superior and inferior maxillæ was formerly known as "winddorn" "spina ventosa," "bone-worm," "maxillary tumor." It arises from superficial granulations on the gums and mucous membranes in the vicinity of the teeth. At first there exists an actinomycotic periostitis ossificans with the formation of osteophytes. If the actinomycoma also involves the bone-marrow, there develops an actinomycotic granular osteomyelitis and rarefying ostitis (myelogenic actinomycosis), with atrophy of the osseous framework and the formation of great hollow cavities. Both processes lead to severe swelling of the superior and inferior maxillae. Frequently the actinomycotic granulation-tissue assumes the

form of a sarcomatous proliferation; it may then pass in the direction of the gums, the molar teeth, the skin, as well as into the maxillary and frontal sinuses. In the horse central actinomycoma occurs in the inferior maxilla with loosening of the teeth. The disease also occurs in the form of an epulis-like extensive actinomycoma of the dental alveoli in the inferior and superior maxillæ (Pilz, Geiger, Schwarz, and others). Central, myelogenous actinomycoma is also observed in other bones: in the sterum, in the dorsal vertebrae, cervical vertebrae (spinal pressure-paralysis in the cow), in the ribs, in the tibia, in the metatarsus (lameness).

ACTINOMYCOMA OF THE PHARYNGEAL CAVITY.—In this place it forms fungus-like, polypoid, soft tubercles or nodules; they are attached by short pedicles, and vary in size from a pea to that of one's fist. They usually proliferate from the pharyngeal mucous membranes on the superior wall beneath the sphenoid bone (anterior pharyngeal actinomycoma), they may arise from the posterior wall of the pharynx in the vicinity of the epiglottis (posterior pharyngeal actinomycoma). They may lead to dyspnea or asphyxia. Formerly they were termed "pharyngeal lmyphomata" or "esophageal fibromata." Similar nodules are found on the mucous membranes of the esophagus, in the larynx, in the trachea, and on the mucous membranes of the trachea, nose, and vagina, as well as on the mucous membranes of the digestive apparatus. In Russia actinomycoma of the lips is especially frequent (more than 40 to 80 per cent of all cases) (Jelenewski).

LYMPH-GLAND ACTINOMYCOMA.—This is a secondary, metastatic process, a sequela of primary affection of the oral and pharyngeal cavities. The subparotid and intermaxillary lymph-glands are most often affected in the form of round or oval, firm nodules; they are painless and vary in size from a walnut to that of one's fist. In horses these actinomycomata occur in the intermaxillary lymph-glands where they attain the size of a hen's egg or goose-egg; when unilateral

they give rise to suspicion of glanders (Baranski, Pilz, Rasmussen, Schmidt, Hartl). In a case described by Schmidt all the lymph-glands of the head and neck, as well as the bronchial glands, were swollen as large as a fist and permeated with actinomycotic foci. In a case of suspected glanders in the horse Hartl found the entire intermaxillary region filled with a firm, flat swelling, it even extended to the cheeks; a finger-thick lymph-vessel cord extended to the angle of the mouth, hard nodules were present at intervals along the cord, they were from the size of a nut to that of an egg; hard nodules the size of a bean were also found in the upper lips and in the region of the parotid. Microscopic examination of the extirpated gland revealed masses of ray-fungi. The salivary glands are also occasionally affected.

ACTINOMYCOMA OF THE SKIN AND SUBCUTEM.—These are primary (infection through a skin-wound) and secondary (outward penetration of deep foci), on the head, neck, udder, scrotum, in the region of the elbow and shoulder, as well as on the abdominal wall. They either form nodules from the size of a hazel-nut to that of one's fist, or fungoid, fleshy-red, soft granulation masses; the latter are either covered with pus, or with dry brownish crusts. Occasionally the adjacent skin undergoes an extensive phlegmonous swelling and schlerosis. Daughter-nodules frequently form in the vicinity of an old focus. Keratogenous formations are less common (Schreiber). Subcutaneous actinomycoma is accompanied by the presence of fistulous openings. In a case described by Hartl a horse suspected of having glanders presented the following symptoms: subcutaneous swellings in the flank and on the ventral surface of the abdomen; these areas were covered with ulcer formations, abscesses and sanguino-purulent secretions; numerous actinomyces fungi were found in the indurated abdominal muscles. Meier observed actinomycotic cutaneous nodules as large as a hazel-nut in the saddle region of a horse. Occasionally actinomycotic proliferations are observed on the anterior surface of the carpal-joint in cattle (one form of so-called knee tumor in working oxen). Actinomycoma has also been found in castration wounds of both male and

female pigs, as well as in the spermatic cord of castrated horses and cattle (Rasmussen, Mazzarella). According to Burke the so-called Madura-foot of elephants is an actinomycosis of the skin.

ACTINYOMCOSIS OF THE UDDER.—This form is most often seen in swine, it is also observed in cows. In the udders of swine one finds numerous nodules, they are imbedded in a firm, fibrous tissue ; in size they vary from a pea to that of a walnut ; they may contain pus, or form large abscesses which occasionally break through the skin. In cattle one observes soft purulent nodules with fibrous induration of the surrounding tissue; they vary in size from a pea to that of a goose-egg, they may be confined to one or more quarters, and occasionally they break through the skin forming ulcers and fistulous tracts. Disseminated actinomycosis of the udder is less common, in this case the entire udder is severely swollen, and becomes hard and rough ; the cut surface reveals numberless soft yellow flecks which vary in size from a millet to a hemp-seed, they contain small purulent foci in reddish nodules (Bang, Jensen, Rasmussen, Kitt).

Actinomycosis of the muscles is of secondary origin from penetrating cutaneous actinomycoma ; Rassmussen has described one case of actinomycotic disease of the muscles of the elbow and shoulder. Görig has observed a case of actinomycosis of the testicles in a bull, which developed after an injury to the scrotum. In dogs, local actinomycotic affections (tumors, abscesses, fistulæ) often accompany pleuritis and peritonitis (Bahr). Actinomycoma of the internal organs (lungs, liver, spleen, kidneys, brain, diaphragm, uterus, bladder) is of no surgical importance.

TREATMENT.—Where operation is possible, extirpation with the knife is the best treatment, the same as in other tumors. Actinomycoma of the tongue, as well as deeply situated actinomycoma of the pharynx responds to the external or internal administration of iodine, which is considered a specific for the disease. The action of iodine seems to be directed to the tissues which surround the growth, as actinomyces fungi flourish on media containing iodine. Ex-

ternally, iodine is administered in the form of tincture of iodine, or as Lugol's solution. The former may be painted on the surface of the tongue, while Lugol's solution may be employed in the form of parenchymatous injections into the tissues of the tongue ; many scarify the tongue and then paint with iodine solutions. For tumors that cannot be operated iodid of potash administered internally is also alleged to be a specific remedy.

According to Thomassen who, in 1885, was the first to recommend the internal treatment with iodine, the following results were obtained : for fourteen days the cattle were given daily doses of six grams of iodid of potash dissolved in one-half liter of water ; with a beginning of improvement the dose was reduced to four or five grams. When the disease was confined to the tongue and surrounding soft tissues, healing averaged to occur at the end of fourteen days, improvement was visible at the end of eight days. Numerous demonstrations of the specific action of iodid of potash have been made. (Fürthmeyer, Bass, de Jong, Ostertag, Deslex, Reeks, Perinni, Havas, Soucail, Hohenleitner, Krug, Nocard, Schwäbel, Walther, Ehrhardt, Salmon, Bang, Jensen, and others). In many cases iodid of potash is ineffective (Immiger, Frick, Bouchet, and others). Bouchet, for example, treated a horse an entire year with iodid of potash (1500 grams in all) without results. In addition to the internal administration of iodid of potash, it may be employed externally in the form of tincture of iodine, or Lugol's solution, either in the form of painting on the surface, or parenchymatous injections. The fact should not be overlooked, that spontaneous reduction of actinomycoma, without previous treatment, has occasionally been observed. Under certain conditions, mere incision of the actinomycoya appears to be followed by healing. Bossi has observed complete healing in two cases of actinomycosis of the tongue in cattle that were treated as follows : simple deep incisions of the tongue repeated three times at intervals of ten days.

II. BOTRYOMYCOMA.

ETIOLOGY.—The name botryomycoma or mycofibroma indicates a chronic inflammatory proliferation of the connective tissue; it is due to the botryomyces fungus that was discovered in 1884 (botryococcus, micrococcus ascoformans, micrococcus botryogenus). It is a fungus formed of roundish cocci arranged in blackberry-like clumps; it has received special investigation from Rivolta, Johne, Rabe, Bollinger, Jensen, Kitt, Hell, de Jong, Poncet and Dor, Parascandolo, and others. Botryomycoma is a neoplasm that very frequently occurs in the horse. Because of its size and malignancy it possesses as great surgical importance as actinomycosis in cattle. I have, for example, operated not less than 400 cases in the years 1895–1903 in a surgical clinic of 8000 diseased horses. These included 175 shoulder tumors, 150 fistulæ of the spermatic cord, and 75 other forms of botryomycoma. Botryomycosis, similar to actinomycosis, may be considered a wound infection disease in which the botryomyces fungus gains entrance through small wounds in the skin, especially operation wounds (castration). Generalization is far less common than in actinomycosis. Botryomycomata that are very important from a surgical standpoint are most often found in the following places: botryomycoma of the skin and subcutem, of the spermatic cord, of the udder, of the nasal mucous membranes, and in the muscles, it is less common in bones. In addition to occurrence in horses, botryomycoma has occasionally been observed in cattle and swine, as well as recently in man.

BACTERIOLOGY.—Formerly the botryomyces fungus was considered identical with ordinary pus-cocci, staphyloccus pyogenus aureus (Hell, de Jong, Galli-Valerio, Kitt). According to recent investigations of Parascandolo, and Poncet and Dor, the specificity of the botryomyces fungus seems to be demonstrated. The inoculation-experiments in horses, as well as the various bacteriological, physiological, biological, and sero-diagnostic relations of both organisms supply evidence against their identity. The botryomyces organism can even possess pyogenic properties—ability to

produce mycofibromata—that are never possessed by the staphylococcus. The staphylococcus forms goldish-yellow cultures in any temperature; the botryomyces organism, however, develops cultures only at a temperature of 18°. Bacteriologically they are alike in form; they take the same stain with aniline dyes; and their grape-like arrangement in clusters is the same. Their development on gelatine is not the same, their properties of immunization are also very different. The pyogenic—not, however, the botryogenic—properties are identical.

BOTRYOMYCOMA OF THE SKIN.—This occurs in the form of tumors that are partly solitary, partly multiple, and occasionally scattered over the entire skin. It most often develops in the saddle and harness regions, on the elbows, tail, fetlocks, lips, and eyelids, in the region of the parotid, at the tarsal-joint and scrotum. Their size is extremely variable; very often they are only the size of a pea to that of one's fist, occasionally, however, they assume an enormous extension becoming larger than any other tumor. At the elbow, in the region of the shoulder, as well as at the fetlock, tumors have been repeatedly found that were as large and larger than a man's head. Occasionally many small nodules are arranged around a primary large nodule. Their consistence is usually firm, at other times they are soft, and may even show circumscribed areas of fluctuation; occasionally fistulous tracts lead into the substance of the tumor. On the cut surface one finds sand-like deposits of botryomyces fungi, as well as areas of liquefaction containing torpid granulation-tissue and small pus-cavities; the latter are enclosed in a tendinous, firm, schlerotic connective-tissue proliferation. Large tumors proliferate from the skin into the subcutem and into the organs that are more deeply situated. I observed one case of actinomycoma on the back in the form of a fistula of the withers.

BOTRYOMYCOSIS OF THE SPERMATIC CORD.—Most cases of so-called fistula of the spermatic cord in the horse are to be regarded as funiculitis botryomycotica, specifically, as botryomycoma of the spermatic cord. Infection of the castration wound takes place through the dust. The stump of the spermatic cord begins to proliferate; the tunica

vaginalis undergoes a chronic induration, and adhesion takes place between the two. They form a hard tumor that varies in size from a man's fist to that of a man's head; in form it is shaped like a walnut. The tumor may extend to the inguinal canal; occasionally it presents fungoid proliferations between the margins of the wound (so-called champignon); it frequently encloses one or more fistulous tracts, the latter open below in one or more funnel-like, constricted, fistulous openings. The fistulous openings discharge a purulent mass containing botryomyces fungi. In many cases the botryomycoma extends from the spermatic cord to the sheath, the adjacent skin of the limbs, and the ventral surface of the abdomen, so that there is formed an enormous tumor several times the size of a man's head. Bilateral fistula of the spermatic cord is common. In extirpated preparations one notes the fatty, firm, tendinous, light-grey, cut surface; on this surface are yellowish-brown, torpid, muco-purulent areas of liquefaction; these areas contain the yellowish-white, sand-like botryomyces colonies, they may be seen with the naked eye.

Botryomycosis of the Udder.—This form is common in the mare (Möller, Sand, Vennerholm, personal observations). The udder is swollen, hard, shows nodular induration, and fistulous openings, as well as circumscribed abscess formation. Typical botryomyces colonies may be recognized in the pus of the fistulous tracts. According to my experience botryomycoma of the udder is a very malignant tumor. Operative removal is liable to be followed by recurrence; for this reason total amputation of the udder is recommended when the disease is confined to one half of the udder. They also have a strong tendency to extend to the abdominal wall and to the inner surface of the limb, extension is apparently rapid. I have observed one case of this kind in which one half of the udder was amputated two years before and the affection apparently healed. Unterhössel has described a botryomycotic neoplasm that weighed 35 kilograms; it was located on the udder of the mare.

BOTRYOMYCOMA OF MUSCLE.—Botryomycotic myositis is especially common in the levator humeri in the form of so-called shoulder abscess; it is also observed in the abdominal muscles, the intercostal muscles, and the lumbar muscles. Botryomycosis of the bones, on the other hand, is apparently rare. In the case described by Kitt, an adjacent botryomycoma was the cause of a rib being transformed into a fungoid, osteoporotic mass. Storch has described a botryomycoma that extended from the maxillary sinus of a horse; the new-formation arose from the mucous membrane, and in two months had reached the size of a child's head; it caused swelling and asymetry of the maxillary sinuses and frontal region, as well as dyspnea and unilateral nasal discharge.

GENERALIZED BOTRYOMYCOSIS.—In comparison with actinomycosis this is very rare. In a case of fistula of the spermatic cord of the horse observed by me botryomycotic proliferations similar to the nodules of pearl-disease were present in the lungs. Tempel and Bedel have observed similar cases of metastatic formation on the diaphragm and in the lungs (a botryomycoma of the uterus was the point of origin in the former case). M'Faydean describes three cases of generalized botryomycosis in horses affected with fistulæ of the spermatic cord (lungs, spleen). Kitt has observed a very interesting case of botryomycotic endocarditis. Hilbrand observed a case of botryomycosis of the kidneys (large tumor in the vicinity of the right kidney, it was adherent to the colon and rectum and filled with abscesses the size of hens' eggs), with numerous botryomycotic abscesses the size of the head of a stick-pin in the liver of a horse. Kofler saw a primary botryomycosis of the spermatic cord followed by metastases in the lungs, in the muscles of the shoulder, the maxillary muscles, and the kidneys. Türnau, when inspecting the flesh of a horse affected with fistula of the spermatic cord, found metastases in the lungs and liver.

Primary or secondary (metastatic) botryomycomata in the lungs and other inner organs are seldom of surgical importance. A transplantation of botryomycoma of the lungs to

the parietal pleura, and from there to the ribs has occasionally been observed in cattle; it led to granular ostitis, with rarefaction and formation of costal fistulæ. Babe has described a botryomycoma of the pelvic cavity that weighed 15 kilograms; it was complicated with fistulæ having external openings, as well as openings in the direction of the bladder.

BOTRYOMYCOSIS IN MEN.—In the past few years several cases have been observed in men. Poncet and Dor (Paris Surgical Congress. 1897) reported four cases; they were in the form of tumors on the fingers, the thorax, and the elbows, they presented the following characteristics: from a pea to that of a nut in size, pedunculated, fungoid, and infiltrated with blood. Ten Siethof (Ref. Münch. med Woch. 1898, No. 15) saw in a man, who had been caring for a horse affected with fistula of the spermatic cord(!), a disease of the palpebral conjunctiva that had the appearance of actinomycosis; it was accompanied by swelling and nodular formation. Typical colonies of botryomycocci were found in the pus of these nodules.

Other cases have been described by Legrain, Sabrazès, Laubié, Délor, Galli, Valerio, and Lenormand.

TREATMENT.—When possible, botryomycoma receives operative treatment, the same as actinomycoma, this should be as early as possible, and in the form of extirpation. To guard against recurrence the incision should be carried a certain distance from the tumor in tissue that is known to be normal. Occasionally a botryomycoma is so multiple or so large that operative removal at one time is impossible. Such cases may be operated at different times. Siedamgrotzky, for example, removed a large multiple botryomycoma from the skin of a horse during six operations which covered a period of three months. I have employed similar partial operations. There are also cases which, on account of enormous size or generalization, cannot be operated.

Iodid of potash has been employed as a specific for botryomycosis, the same as actinomycosis. Thomassen gave horses daily doses of 10 grams of iodid of potash, the spermatic cord was treated locally with tincture of iodine, after a month the tumors were markedly smaller. Siegmund gave doses of 12 to 15 grams of iodid of potash three times per day, so that the horse had 800 grams in all, 1200 grams were given to another; he reported satisfactory results.

Ostertag, Malkmus, and others, report similar results from the use of iodid of potash. According to my own experience and experiments the beneficial action of iodid of potash has not been supported. In a horse affected with botryomycosis of the spermatic cord, the skin, the abdominal muscles, and the lymph-glands, neither the internal administration of 325 grams of iodid of potash, nor the subsequent intratracheal injection of 210 grams of iodate of soda, produced visible improvement. The disease process had rapidly extended regardless of the iodine treatment. Another horse with botryomycosis of the spermatic cord was given 750 grams of iodid of potash during a period of five months without visible improvement; on the other hand, he soon developed symptoms of chronic iodism. The horse was operated and soon healed, Vennerholm, König, and Winter have recorded similar failures of iodid of potash in the treatment of botryomycosis of the udder. Töpper has also spoken against the iodid of potash treatment; he maintains that a trial is only indicated when the diseased tissue cannot all be removed by means of an operation. In any case it is not correct to advise the owner of a horse against the employment of an operation for the relief of botryomycosis of the spermatic cord, in preference to the iodine treatment, a more certain and rapid healing results from operating as early as possible.

III. TUBERCULOSIS

Surgical Importance. While in human surgery tuberculosis of the bones, joints, and other external organs is of great practical therapeutic importance, the same form in domestic animals is of less significance. This is explained by the fact that tuberculosis of the external organs is far less common in animals than in man. Many valuable surgical operations employed upon man—resection of tubercular joints for example—are not practical in the lower animals. Finally, tuberculosis is found principally in slaughtered animals (cattle, swine); localized external tuberculosis is of slight importance

to the animal; that form of external tuberculosis which is secondary to a generalized type is incurable.

If, regardless of previous statements, tuberculosis of cattle from a surgical standpoint is somewhat exhaustively considered in the following pages, it is due to the fact that such a classification has never found place in text-books on veterinary surgery. Like so many other chapters of surgical publications, the one under consideration has been sadly neglected. If tuberculous animals are excluded from surgical treatment, as has already been explained, the diagnosis of tuberculous changes, in itself, is of greatest importance, because of the close similarity of many tubercular affections to disease processes that may receive successful surgical treatment. Only the following are mentioned here: differential diagnosis of mastitis and metritis, tubercular arthrites and tendovaginites as causes of different forms of lameness, as well as spinal tuberculosis as a cause of paralysis. In all these cases an early diagnosis of a surgical affection as tuberculous, and therefore, incurable, is of interest for the rapid repression of contagion (Ostertag's method of repression), as well as of economic interest to the agriculturist. With reference to the etiology and pathogenesis of tuberculosis (tubercle bacillus) see text-books on special pathology.

TUBERCULOSIS OF THE UDDER.—In cattle this is usually secondary, due to emboli; it is seldom primary (entrance of bacilli through the teats). Anatomically it may be a disseminated miliary tuberculosis, a tubercular mastitis, or a localized tuberculosis. It usually presents the following symptoms: a diffuse, symmetrical, painless, seemingly firm swelling of the posterior quarters, with swelling and enlargement of the supramammary lymph-glands. Later the swollen parts contain large or small firm nodules, on palpation these appear to be very hard. Other parts of the swollen udder gradually become as hard as a board or stone. Occasionally the udder becomes extremely large, the disease may extend from the posterior to the anterior quarters. Diminution in size of the

udder, as shown in other chronic forms of inflammation, is never seen in tuberculosis of this gland (Rabe). In contrast to other inflammations of the udder, the milk is at first normal; later it becomes thin, watery, mixed with floculi, and frequently contains bacilli (Bang). Diagnosis is confirmed by harpooning the udder (Nocard, Ostertag). Tuberculosis of goats is far less frequent. As yet only one case has been observed in the horse (Parascandolo and de Meis).

TUBERCULOSIS OF THE LYMPH-GLANDS.—Infection of the lymph-glands occurs partly through the lymph-stream, partly from the blood. Swelling and induration of the tubercular lymph-glands is due to the deposit of tubercular nodules, which afterwards become calcified, as well as to proliferation of the interfollicular connective tissue. The following glands produce forms of external surgical tuberculosis: on the head, the lymph-glands in the vicinity of the parotid; on the neck, the superior (retropharyngeal), middle, and inferior cervical glands; on the anterior extremities, the shoulder and axillary glands (shoulder lameness); on the posterior limbs, the inguinal and popliteal glands; on the udder, the pubic glands (supramammary glands); on the hips, the external iliac glands. Tuberculosis of the following glands belongs to the realm of inner pathology: those in the thoracic cavity, bronchial, and mediastinal, as well as intercostal and sternal lymph-glands; those in the abdominal cavity, omental glands, lumbar and sacral glands, as well as the glands of the liver, spleen, and kidneys. Extensive enlargement of the bronchial and mediastinal glands may lead to symptoms of surgical importance when they press upon the esophagus, causing symptoms of esophageal stenosis (chronic tympany). The other internal glands are of no surgical significance. Brückmuller has observed a case of tuberculosis of the thyroid gland in cattle.

Johne and Röder have described a case of tuberculosis of the glands of the shoulder in a horse,

it was in the form of a shoulder abscess. Nocard has demonstrated, through extirpation and bacteriological examination, one case of tubercular disease of the intermaxillary gland in a horse that was suspected of having glanders. Rabe observed a case of tuberculosis of the intermaxillary, subparotid, and superior cervical glands, with compression of the larynx and high-grade inspiratory dyspnea; the tubercular tumor weighed 3½ kilograms.

TUBERCULOSIS OF THE SKIN AND SUBCUTEM.—This form is very frequent in parrots, as a rule it is primary, in fifty per-cent of all cases only the skin is involved (Eberlein). Tuberculoma is found in the angle of the lids, on the eyelids, and on the top of the head. Upon and beneath the skin they form soft tumors from the size of a stick-pin to that of a hen's egg, in form they are oval or round, they may also form keratogenous structures in the skin that are easily broken. Occasionally one also finds small and large tuberculous ulcers on the skin, in which large numbers of tubercle bacilli are demonstrated. Cadiot observed an interesting case of nasal tuberculosis in a cat, it was accompanied with extensive ulcerous destruction of the skin, of the mucous membranes, and the nasal and turbinated bones (Cf. Vol. III. Pg. 209 of this hand-book). Tuberculosis of the skin is not common in cattle. A few cases have been observed in cattle; they were characterized by the formation of caseated or calcified nodules on circumscribed areas, or by the appearance of swellings the size of a hazel-nut to that of a walnut or a man's fist over the entire surface of the body. Afterwards these swellings became soft and caseous, their contents contained tubercle bacilli (Hüttner, Langdon, Degive, Stubbe, Lacaze, Hanozat, Mischkin, Winter, Mackel, and others). Godbille and Nocard observed the following case of tuberculosis of the subcutem in an ox: tubercular lymphangitis, with irregular, subcutaneous tumors arranged in rows; they were about the size of a man's fist, and became fluctuating and ruptured on the external surface of the right anterior foot. In a dog Möller found a tuberculous ulcer on the throat, it was accompanied by swelling of the lymph-glands. In a cat he observed

subcutaneous tubercular nodules with swelling of the axillary glands. Tubercular castration-cicatrices have been repeatedly observed in swine (infection from men?).

TUBERCULOSIS OF THE MUCOUS MEMBRANES.—This is most often found in cattle in the larynx and in the trachea in the form of tuberculous neoplasms, ulcers, and nodular hyperplasias of the mucous membranes, or tubercular infiltration and abscess formation of the submucosa, the parachondrium, and the adjacent musculature. Tuberculosis of the mucous membrane is common in parrots, it affects the oral mucous membranes and conjunctiva in the form of tumors and ulcers. Occasionally one observes in cattle an ulcerative, tuberculous stomatitis and glossitis (Moussu), as well as tuberculosis of the nasal mucous membranes in the form of numerous conglomerate fatty nodules on the nasal septum; they vary in size from the head of a stick-pin to that of a pea, and are accompanied with nasal discharge and dyspnea (Zimmerman, Strerathy, Bollinger, Kitt, and others). Johne and Eber have described a case of tuberculosis of the mucous membrane of the prepuce of an ox. Montfallet described a case of tuberculosis of the tongue in swine. Tuberculosis of the mucous membrane of the uterus in cattle is very common, that of the vagina is less frequently affected. Tuberculosis of the uterus presents the following appearance: the mucous membrane is covered with yellowish-white tubercles, ulcers, caseous foci, and abscesses; the uterus contains a cloudy, greyish-red, ichorous fluid (identical with a bacilli-containing vaginal discharge), the serosa is covered with villous proliferations; occasionally the uterus is very much enlarged, the walls of the horns in particular become very thick, hard, nodular, and covered with ring-shaped constrictions; the oviducts often become thickened to the size of one's finger. The sacral glands are usually enlarged and indurated. Tuberculosis of the vulva usually exists at the same time: on the inner surface one finds numerous indurated nodules the size of a stick-pin, as well as ulcers the size of beans (Hess). Tuberculosis of the uterus is usually the result of tubercular peri-

tonitis, it is rarely embolic ; and is seldom the result of infection at the time of copulation (De Bruin).

Tuberculosis of the Bones and Joints.—Tuberculosis of the bones is usually an incidental symptom of generalized tuberculosis, and is, therefore, embolic. In most cases the primary seat is in the bone-marrow (osteomyelitis granulosa, caries centralis tuberculosa); it is characterized by the formation of greyish-red granulating foci and lacunar liquefaction (caries) of the osseous tissue, with central cavernous formation and caseation. In cattle and swine tuberculosis of the bones is often found in the following places: the dorsal vertebrae, lumbar vertebrae, cervical vertebrae (especially the first and second cervical vertebræ as a result of tuberculosis of the adjacent retropharyngeal lymph-glands), the petrous portion of the temporal bone, the sternum, and the ribs; it has also been observed in the ethmoid bone, frontal bone, occipital bone, humerus, pelvis, femur, on the tibia, and in other bones. A peculiar form of tuberculosis of the middle ear (tubercular otitis media and interna) is observed in swine, it penetrates towards the brain, and develops from an infection of the pharyngeal cavity (Schütz, Siedamgrotzky). The tubercular inflammation extends through the Eustachian tube, and then over the tympanic cavity ; it develops a tubercular periostitis, ostitis, and osteomyelitis, with rarefaction and necrosis of the bones, in this manner the process may extend to the cerebral meninges, the cerebellum, and the medulla oblongata. The tubercular affection may extend to the external auditory canal, which becomes filled with a tubercular tumor. A secondary tuberculosis of the brain may develop in cattle in a similar manner from primary tuberculosis of the frontal bone (Künnau, Moussu). Tuberculosis of the petrous portion of the temporal bone in a dog has resulted in unilateral facial paralysis (Montfallet). Hess has described a case of kyphosis in a steer caused by tuberculosis of the lumbar vertebræ. Rieck observed a case of paralysis of the hind parts in a bull caused by tuberculosis of the sixth cervical vertebra, it resulted

in severe swelling and compression of the cervical marrow. Knoll has observed two cases of sacral paralysis in swine following tuberculosis of the lumbar vertebræ. Teetz has observed a case of paralysis in swine as a result of tuberculosis of the first cervical vertebra, Heyne has observed a similar case in a cow (seventh cervical vertebra, first dorsal vertebra). Schmidt saw a cow collapse with sudden paralysis; it was necessary to kill the animal, post mortem revealed tuberculosis of a lumbar vertebra and the adjacent spinal marrow. Haug has described a similar case. Tuberculosis of the bones is common in birds. Cases of tuberculosis of the lumbar vertebræ, ribs, etc., have been observed in horses, sheep, and goats (Walley, Rasmussen, Magin).

Tubercular arthritis is occasionally found in cattle in the hip-, elbow-, knee-, and carpal-joints (arthritis pannosa, granulosa, and caseosa), compare with the chapter on arthritis. It is most often seen in birds, especially in the joints of the feet and wings; it also occurs in swine in the tarsal- and carpal-joints. By feeding tuberculous milk Nocard produced tubercular arthritis experimentally in a cat. Cadiot observed tubercular gonitis in a dog. With reference to tubercular tendovaginitis and bursitis at the carpal-joint (extensor carpi radialis), and knee-joint (extensor digitorum pedis longus) of cattle, compare with the chapter on tendovaginitis and bursitis.

Tuberculosis of the Musculature.—This is mostly of an embolic nature (generalized tuberculosis), it is not common and has no surgical importance. In the abdominal, thoracic and appendicular muscles one finds round, firm, sharply circumscribed greyish-brown nodules; occasionally they are arranged in rows; they may be miliary in form, or attain the size of a lentil or bean. Tuberculosis of the tongue in parrots is more common, where it not infrequently leads to active tumor formation in this organ. Tuberculosis of the tongue in cattle is less frequent (Laquerrière, Godbille, and others); according to Ostertag only one case was found during a period of ten years in the abbatoirs in Berlin.

TUBERCULOSIS OF THE EYES.—While tuberculosis of the lids and conjunctiva is common in parrots, in cattle tuberculosis of the eye is relatively rare. It usually develops in the form of an embolic tuberculosis of the iris and choroid, and leads to destruction of the bulb, and transformation of the same into a granular or caseous mass. In a three-year-old cow that was affected with tuberculosis of the lungs, Röder found tuberculosis of the right eye. Hess observed the following condition in a cow that was affected with tuberculosis of the lungs: symptoms of suppurative conjunctivitis, blindness, and atrophy of the bulb, first the left and then the right eye became affected. Post mortem revealed numerous white points in the anterior chamber, as well as fibrinous iritis, and white caseated nodules the size of a millet-seed. In a slaughtered tuberculous cow Winter found the entire inner eye filled with a caseous mass; nodules from the size of a lentil to that of a pea were found on the schlera and cornea, where they were arranged in masses.

In another case lentil-sized, yellow nodules were found on the anterior surface of the iris, it was also covered with yellow foci the size of the head of a stick-pin, the latter were arranged on the inferior margin of the iris, and were adherent to the cornea. In a third case the retina was covered with numerous tubercular nodules. Edelman has described a tuberculous neoplasm that was located within the bulb of a tuberculous ox, it pressed the lens out of position and caused atrophy of the vitreous humor; the neoplasm possessed the consistency of a sarcoma, it was divided into cavernous spaces which were filled with a muco-purulent mass. Similar cases have been described by Moncet, Matthieu, Hess, Ripke, and Schmidt. Amaurosis resulting from pressure on the optic nerve from tubercular new-formations is less common (Fumagalli).

TUBERCULOSIS OF THE TESTICLES.—Many cases of this type have been demonstrated in cattle and swine in the form of enlargement of the testicles, and deposits of numerous tubercular nodules, the nodules vary in size from a millet-seed to a walnut (Perroncito, Lydtin, Kitt,

Johne, Fambach, Göring, Arens, Schmidt, and others). In one case in swine the right testicle weighed 3½ kilograms, the left 10 kilograms. Jensen has described a case in the cat. Hess has observed a tuberculous tumor as large as a goose-egg upon the epididymus of an ox. Meyer and others have described cases of tuberculosis of the spermatic cord, vaginal tunic, and vesiculæ seminales. Cadiot and Frauenholz have reported cases of tuberculosis of the prostate in cattle and dogs. The numerous cases of tuberculosis of the oviducts belong to the domain of inner pathology.

TUBERCULOSIS OF THE BRAIN AND SPINAL MARROW.—Tuberculosis of the brain is not rare in cattle; it occasionally develops with symptoms of paralysis and conditions which are of surgical interest from a standpoint of differential diagnosis (paralysis of the facial, oculomotor, optic, trochlearis, hemiplegia, staggering movements, torticollis). Symptoms of sacral paralysis and ataxia have been observed in tuberculosis of the spinal marrow, tubercular neoplasms in the lumbar marrow have been demonstrated by Johne, Steuding, and others.

With reference to the treatment of tuberculosis, experimental extirpation of the diseased portion may be employed, as in man, (castration, ovariotomy). One may also experiment with aseptic injections of sterilized iodoform, emulsion of iodoform glycerin (10 per cent). These are injected into the diseased organs, for example, into dogs.

CONCREMENTS AND FOREIGN BODIES.

1. CONCREMENTS.

GENERAL CONSIDERATIONS.—The name concrement is used to designate hard, stony excretions composed of the saline and organic constituents of the secretions and excretions of the

animal body. Only a small number of these concrements are of importance in veterinary surgery. The majority, namely, intestinal stones of the horse, hair balls in the rumen and reticulum of ruminants, gall-stones, renal stones, and pancreal stones are essentially conditions of inner pathology ; as a rule they produce only symptoms of internal disease, and, with few exceptions, are not amenable to surgical treatment. The following will receive brief mention :

1. Urinary calculi.
2. Intestinal calculi.
3. Salivary calculi.
4. Milk calculi.
5. Preputial calculi.
6. Free bodies in joints and tendon-sheaths.

URINARY CALCULI.—These either exist in the kidneys and the pelvices of the kidneys (renal calculi), or in the bladder (cystic calculi), they frequently become lodged in the urethra (urethral calculi).

They are formed from the urinary salts, and are composed of calcium carbonate (carbonates), calcium oxalate (oxalates), salts of silicic acid (silicates), uric acid and uric-acid salts (urates), and phosphates of ammonia and magnesia (triple phosphates). The formation of urinary calculi is favored by the presence of foreign bodies on the one hand, especially the organic albumenous products of inflammation of the mucous membranes of the bladder and pelvices of the kidneys, around which, as a nucleus, the urinary salts are deposited, and bacteria on the other hand, these cause degeneration of the urinary products to ammonia (ammoniacal urinary fermentation), thereby making possible the formation of triple phosphates.

In the horse urinary calculi are composed largely of calcium carbonate with traces of calcium oxalate, and iron. Cystic calculi form egg-shaped or flat, hard, yellowish stones, the surface is smooth, mulberry-like, or has the appearance of a gland ; in size they vary from that of a walnut to one's fist or larger. Frequently a few, and even many small calculi are present in the bladder. By constant wear they produce

facet-like surfaces on one another; in addition to these one also finds a gravel- or sand-like sediment (urinary gravel, urinary sand). The weight of cystic calculi varies between 10 and 1000 grams. Urethral calculi are similar in character but smaller, they vary in size from a hazelnut to that of a chestnut, and average from 10 to 15 grams in weight. They are usually situated in the vicinity of the posterior border of the ischium.

Cystic calculi in cattle possess the following characteristics: they are usually numerous, small in size, from a lentil to a pea, pearl-like, of a metallic goldish-yellow or goldish-brown lustre, and covered with facets. In oxen and steers they are usually found lodged in the S-shaped curve of the urethra. They are composed of the carbonates or oxalates of lime, or of silicates.

In dogs the cystic and urethral calculi are usually small, from the size of a grain of sand to a pea, and they often exist in large numbers. Solitary cystic calculi, from the size of a hazelnut to a chestnut, are less common. From lying against one another their surfaces are frequently smooth and covered with facets similar to the cuboïd, one often finds, however, a rough, gland-like, warty surface. Urethral calculi in dogs usually become lodged in the gutter of the bone of the penis, so that the entire urethra as far as the bladder is filled. Occasionally one finds a sand-like incrustration of urinary sediment on the mucous membrane of the urethra. The urinary calculi of the dog are composed largely of urates, triple phosphates, and oxalates.

The treatment of urinary calculi is purely operative; it consists in incision of the bladder (cystotomy), and the urethra (urethrotomy).

INTESTINAL CALCULI.—In the horse these are formed in the large intestines, by getting lodged in the rectum, or at the point where the colon terminates in the rectum, they become the cause of so-called calculous colic. They consist essentially of the triple phosphates which are derived from the phosphates of magnesia in the food (bran) and the ammonia in the air of the stall. The phosphates of ammonia and mag-

nesia frequently crystalize around an oat, a nail, a button, a grain of sand, etc., which serves as a nucleus. Their size is variable, the large ones reach the size of a large nine-pins ball and weigh from 5 to 10 kilograms. Intestinal calculi are of surgical importance when they can be reached per rectum. Operative removal by means of laparotomy and intestinal incision is as good as hopeless. Félizet successfully removed an intestinal calculus by this method; on the other hand those cases in the horse terminated fatally that were operated on by Dollar, Rickards, and Hall.

Hair-balls (bezoare, phytobezoare, ægagropila) in the rumen and reticulum of ruminants are composed of matted hairs and plant fibers. In cattle they reach the size of an apple to that of one's fist. When regurgitated they occasionally obstruct the esophagus producing symptoms similar to those of foreign bodies in the esophagus (tympany). In these cases operative treatment is indicated (probang, esophagotomy).

SALIVARY CALCULI.—In herbivora these are found in Steno's duct (horse, cow, ass). They consist largely of the salivary salts, namely, calcium carbonate (80 to 90 per cent), besides phosphate of lime and organic material; they have a chalk-white or yellowish-white color and occasionally reach a considerable size, when they become as large as a goose-egg and weigh 500 grams. Solitary calculi are oval or sausage-shaped, they are covered with numerous facets. A foreign body is usually found in the center of the calculus (oat, etc.). They are removed by means of an operative opening in the salivary duct, or through the mouth. The so-called dental calculi on the teeth of horses and cattle are composed of the same materials as salivary calculi, calcium carbonate is the main constituent.—Calcareous concrements in the tonsils are very rare.

FREE BODIES.—The name free body (corpora libera, corpora oryzoidea, rice-like bodies, chondroids, joint-mice) indicates an organic structure in joints, tendon-sheaths, mucous bursae, subcutaneous hematomata, and the guttural pouches of the horse; these structures are variable in

character. More than a hundred chondroids have frequently been found in the guttural pouch. They are composed partly of coagulated, inspissated, hardened, calcified products of inflammation, partly of constricted neoplasms or desquamated bone or cartilage. See chapter on diseases of the joints.

MILK-CALCULI.—This is a name that indicates concrements in the milk-cysterns or in the teats. They are variable in form, yellowish-white or grey in color, and about the size of an oat or bean. They consist of calcium carbonate (90 per cent), casein, and fat. Weille has described a case in a heifer in which 22 milk-calculi were removed at an operation, their collective weight was 72 grams.—The so-called prostatic calculi are similar concrements which are formed from the sedimental deposits from the secretions of the prostate.—Preputial Calculi. Concrements known as preputial calculi, or calculi of the glans penis, are found in the preputial sac of horses and boars. They are oval or lenticular in form, smooth or sharp, rough, and formless. They consist largely of inspissated smega, occasionally they cause retention of the urine (urinary colic).

II. FOREIGN BODIES.

GENERAL CONSIDERATIONS.—Aside from foreign bodies that are formed within the animal body itself (concrements) many other foreign bodies from without gain entrance to numerous portions of the body. In some ways they are of more importance to internal medicine than to surgery, namely, foreign bodies in the anterior stomachs of the ruminant (traumatic inflammation of the stomach, diaphragm, and heart). In many cases they produce conditions that necessitate surgical interference. To this class belong foreign bodies of the mouth-cavity, the pharynx, esophagus, stomach, intestines, the nasal cavities, the conjunctival sac, skin, subcutem, muscle, and hoof.

FOREIGN BODIES OF THE MOUTH CAVITY.—These are most often observed in dogs, cats, and horses, where they cause symptoms of salivation, stomatitis, and difficult mastication; in dogs, under certain conditions, they even produce symptoms similar to those of rabies. When such symptoms exist in these animals careful examination of the mouth cavity should not be omitted. The following bodies are found

between the teeth, in and under the tongue, in the gums, in the mucous membranes of the cheeks, at the openings of the secretory ducts of the salivary glands, etc.: pieces of bone-splinters, grain, pieces of wood, needles, particles of straw, and other sharp bodies. Sometimes the tongues of cats and dogs, as well as birds, become ligated with pieces of string or hair, they may also become constricted with pieces of the trachea, transverse sections of the aorta, rubber tubes, and iron rings. In cattle, even green stalks of sharp, pointed barley with long roots have been observed upon the tongue. Oats, rye, awns, and particles of straw have been found in the excretory ducts of the salivary glands. These foreign bodies pass out of the mouth cavity and sometimes follow a peculiar course. Needles and grain-awns have been found in the cranial cavities of horses and swine; a piece of metal was found in the Eustachian tube of a dog; blades of straw and kernels of grain in the orbital cavity and temporal fossa of a horse.

FOREIGN BODIES IN THE PHARYNX AND ESOPHAGUS.—These are especially frequent in horses and cattle, where they cause symptoms of pharyngitis, difficult deglutition, stenosis of the esophagus, and even perforation of the esophagus. The most important foreign bodies are bones, pieces of meat, fish-bones, bacon-rinds, masses of fat, pieces of tendon, potatoes, beets, apples, pears, pieces of linseed cake, balls of food, eggs, sauerkraut, plum-stones, pieces of wood, needles, pills, teeth, forks, knives, spoons, coins, pieces of cloth, hair-balls, broken pieces of whip-handles and probangs, balls of oakum, and remains of the afterbirth. Their removal is often very difficult. Treatment consists in the administration of emetics (apomorphine, veratrin), agents which stimulate the secretions of the salivary glands (arecalin, pilocarpin), passing the probang and esophagotomy. Those cases in which the foreign body has penetrated the thoracic portion of the esophagus are incurable (pleuritis); occasionally a foreign body causes an injury to the anterior or posterior aorta resulting in internal hemor-

rhage, or an aneurysm of the aorta.—In the guttural pouches of the horse, aside from the chondroids which reach the size of a chestnut to a hen's egg, there may be found necrotic portions of the bone (os hyoides), as well as pieces of food which occasionally fill the entire sac. In one case a musket-ball three centimeters thick was found in the guttural pouch of an old military horse (Rigot). In another case fungoid growths of aspergillus fumigatus were found in the guttural pouches (Ries).

Foreign Bodies in the Stomach and Intestines.—The greatest variety of blunt and pointed foreign bodies are found in the anterior stomachs of the ruminant, especially in the reticulum of the ox. Pointed foreign bodies penetrate the gastric wall, the diaphragm, pericardium, and heart, causing a characteristic disease marked by chronic indigestion and severe cardiac symptoms (traumatic carditis and gastritis). In their wanderings the foreign bodies often pass outwards through the skin, their passage is characterized by the formation of phlegmons, abscesses and fistulæ of the thoracic and abdominal regions. The most common sharp foreign bodies are: nails, pins, darning-needles, hair-pins, sewing-needles, cobbler's needles, pieces of wire, sharp remnants of iron and metal plate, screws, knives, shears, forks, pieces of glass, splinters of wood, pieces of stone, sharp angular pebbles, sharp pieces of lead, pieces of thorns, branches of vines, steel umbrella-ribs, and broken umbrella-sticks. The most common blunt foreign bodies are: stones, pieces of brick, gravel, sand, coal, pieces of wood, cork, cabbage-stumps, apples, pears, hair-balls, bullets, spoons, pieces of coin, leather straps, soles of shoes, pieces of cloth, pieces of clothing, neck-ties, strings, laces, buttons, frogs, toads, striped snakes, adders, and poisonous plants. Surgical treatment of these foreign bodies consists in the much-employed laparotomy and gastrotomy (incision of the rumen). Foreign bodies in the stomach and intestines of dogs (bullets, coins, stones, cork, hair-balls, pieces of teeth) are occasionally removed by means of emetics and purgatives. Otherwise, when symptoms of death appear, they must be removed by means of laparotomy. The

prognosis of enterotomy in the dog is not unfavorable; it has been employed with good results by Siedamgrotzky, Fröhner, Degive, Plósz, Krause, and others. Occasionally foreign bodies in dogs and horses pass away spontaneously (champagne-cork in a dog, curb-chain in a horse). It sometimes occurs that foreign bodies, especially coins, remain in the stomach of a dog for a long time, even years, without causing trouble. A five-frank piece remained in the stomach of a dog for twelve years without giving rise to injury, a top for one year (Nichoux, Cadiot). In addition to the above foreign bodies, one finds the following in the rectum of the dog and cat: hard feces, fish-hooks, kernels of grain, and other bodies which gain entrance from without. In the urethra, kernels of grain and broken pieces of catheters have been observed; artificial ligatures have been observed around the penis in dogs (ribbons, etc.).

FOREIGN BODIES IN THE RESPIRATORY TRACT.—The following have been observed in the nasal cavities and superior maxillary sinuses of the horse: pieces of food and bone, sponges, wisps of straw, oakum, tampons, pieces of wood, blackberry twigs, hog's bristles, apples, pieces of bandage, and moulds (mucor spinosus). In the larynx and bronchi have been found pieces of cartilage, as well as portions of a tracheotomy-tube, aspirated stones, and grain-awns. Rhinoliths are rare; this type is usually seen in the guttural pouches in the form of corpora oryzoidea.

FOREIGN BODIES IN THE EYE AND EAR.—Foreign bodies in the conjunctival sac, especially beneath the membrana nictitans (kernels of grain, awns, pieces of wood), are the cause of a unilateral purulent conjunctivitis. When a unilateral blennorrhea exists, careful examination of the entire sac for the presence of foreign bodies should not be overlooked. Treatment consists in removal under the influence of cocain. Foreign bodies in the external auditory canal are usually in the form of parasites; occasionally they gain entrance to the middle ear (tympanic cavity), bird-mites, in cattle, mange-mites in rabbits, larvæ of fleas, and fleas

(simulium) in animals at pasture. In addition to these, masses of secretions from the ceruminous glands, water, sand, splinters, beards of grass, and gravel stones have been found.

FOREIGN BODIES IN THE HOOF.—Nails and fragments of glass are most frequently found. They usually enter at the lateral or median cleft of the frog. Nails sometimes penetrate the soles of cats and dogs.

FOREIGN BODIES IN THE SKIN, SUBCUTEM, MUSCLES, BONES AND INTERNAL ORGANS.—Bullets, needles, splinters of wood, and other foreign bodies enter the body through the skin. By acting as carriers of filth, dirt, and other unclean material rich in bacteria, they set up suppurative and septic inflammations (phlegmons, abscesses); when the foreign bodies are aseptic healing occurs without reaction, especially without suppuration. The latter is especially true of shot and bullets, which may become encapsuled and remain in the body without causing injury. Foreign bodies that are soft and composed of animal tissues are resorbed by means of phagocytosis and liquefaction (catgut, pieces of lung, liver and kidneys that are experimetally transplanted into the abdominal cavity).

Other foreign bodies would include the entrance of air into the veins and heart, as well as phlebotomy instruments that gain entrance to the heart by passing through the wounds in the vein (funnel, blades of a lancet). It is a peculiar fact that heart-muscle is relatively non-sensitive to injuries from foreign bodies ; this is demonstrated in those cases of traumatic carditis in the ox, where the function of the heart is not suspended for weeks and months, although severe chronic changes are taking place. With reference to retention of the afterbirth see text-books on obstetrics.

PARASITES. The following parasites, which may be considered as living foreign bodies, are of surgical importance:

1. Coenurus cerebralis (the worm which causes staggers) develops in sheep and cattle, occasionally in horses, dogs, and goats. In the brain they result in symptoms of paresis, and occasionally produce local symptoms (amaurosis); in the spinal marrow they may cause symptoms of sacral paralysis. Treatment of the cerebral bladder-worm is operative (trepanation, puncture).

2. Oestrus ovis (gad-fly) in sheep causes symptoms of chronic catarrh of the nasal cavities, and the frontal and maxillary sinuses (disease caused by the œstrus larvæ).

3. Gastrophilis larvae occasionally produce proctitis in the rectum of the horse, they seldom cause injury in the pharyngeal cavity. Gastrophilis nasalis is very rare in horses (nasal discharge, suspected glanders).

4. Pentastomum taenoides (lingulata tænoides) is parasitic in the nasal cavities of the dog (rarely in horses). They cause symptoms of severe, sanguino-purulent rhinitis.

5. Hypoderma bovis (œstrus humanis) lives in the larval form in cattle, where it causes boil-like swellings as large as a walnut in the skin (œstrus abscesses). These are subcutaneous abscesses, and they communicate with the surface of the skin by a small opening, through which the larvæ finally pass out. Œstrus abscesses have also been observed in military horses and English sale-horses in the following places: in the saddle-region, on the withers, on the buttocks, on the neck and abdomen (Hell and others). In a case described by Ducasse he found a larva of hypoderma (bovis?) one and one half centimeter in length in the medulla oblongata of a horse affected with paralysis. Treatment consists in incision of the abscesses. Chronic connective-tissue proliferations occasionally develop around the dead larvæ, their consistence is very hard and they finally become calcified (hypodermoliths of Caparini).

6. Filaria papillosa lives parasitically in the horse in the anterior chamber of the eye, where it causes a severe inflammation of the iris and cornea. It may be removed through an incision in the cornea (Vandevelde, Monatshefte für praktische Tierheilkunde. 1895). The same parasite is found in the horse in hydrocele, ascites, and cryptorchids.

7. Filaria lachrymalis is a harmless parasite found in the excretory ducts of the lachrymal glands, occasionally it appears to cause a conjunctivitis of the lids.

8. Filaria (Spiroptera) cicninnati (s. reticulata) is a cause of tendinitis of the suspensory ligament, it causes an incurable lameness (Mauri). Occasionally they cause a fibroma-like neoplasm in the vicinity of the flexor tendons, which reaches the size of a hazelnut to a dove's egg (Fröhner, Bartels). They are also found in the tendon-sheaths of the flexor tendons, in the walls of the tibial artery, and in the ligamentum nuchæ (I once found them in the latter place when operating fistula of the withers). One case has also been observed in the subcutem of the horse (Bassi).

9. Filaria hemorrhagica (filaria irritans) develops in horses at pasture, especially in Russia and Hungary. It is found in various parts of the body (withers, shoulder, neck), where it forms hemorrhagic

cutaneous nodules the size of a pea, so-called granular dermatitis. The parasite lives in the subcutaneous tissue and can be demonstrated by means of an incision. In general, treatment is superfluous. (For details concerning this organism see "Special Pathology and Therapeutics," Friedberger and Fröhner. Sixth Ed., 1904, Vol. I).

10. Filaria medinensis occurs, as in men, in the subcutaneous connective tissue of horses and dogs (Africa, India, Brazil).

11. Cysticercus cellulosae (measles) is occasionally seen in the eyes of swine. In one case they were found in a tumor on the knee of a dog (Meyerstrasse).—Echinococci in the frontal sinuses of the horse cause symptoms of empyema (Preuss. Mil. Vet. Bericht. 1898).

12. Strongylus armatus is found in the thickened nasal mucous membrane of the horse (Lammers). It also causes peritonitic proliferations on the tunica vaginalis of the testicles (Hinrichsen), and is not rare in cryptorchids (personal observations). Strongylus-like nematodes have also been observed in the membrana nictatans of puppies in France and America, where they were the cause of a contagious inflammation of the eyes (Emmerz, Mégnin).

13. Spiroptera sanguinolenta produces cysts in the walls of the esophagus in the dogs of Java, this results in stenosis.

14. Distomum hepaticum is occasionally observed in the scrotum of the horse as an incidental condition during castration (Hiller).

15. Sarcosporidia (psorospermia, Miescher's tubules) cause symptoms of myositis in the horse; compare with the chapter on diseases of the muscles.

16. Horse-leeches (hemopis vorax) are occasionally found in horses and cattle in the mouth-cavity, pharynx and larynx (pharyngitis, laryngitis, chronic marasmus).

17. Ixodes ricinus (mites) induce circumscribed inflammation of the skin of dogs; one case of acarus of the conjunctival sac has occurred in dogs (lower border of the cornea), it caused severe conjunctivitis (Tierarzneischule in Pisa; Clinica veterinaria. 1897).

18. Simulium maculata, and Simulium ornata and reptans cause inflammation of the skin and mucous membranes of the head with severe swelling (dyspnea, asphyxia, poisoning) in animals at pasture. According to Bergmann the best protective is creolin in oil or fish-oil (1 to 20).

CHANGES IN POSITION OF VISCERA.

I. HERNIAS. VISCERAL HERNIAS.

NATURE. The term hernia indicates the passage of viscera from body-cavities without an injury to the skin or mucous membranes. Changes in position of the viscera which are accompanied by a rupture of the covering skin or mucous membrane so that they are exposed to the air are termed prolapse. While in a broad sense the term hernia applies not only to abdominal viscera, but also to lungs, brain, and muscle; in a narrow sense one understands by the term hernia, a change in position of the abdominal viscera. According to the seat they are named as follows: umbilical hernia, inguinal hernia, scrotal hernia, ventral hernia, hernia of the flank, femoral hernia, perineal hernia, rectal hernia, vaginal hernia, diaphragmatic hernia, and other internal hernias.

In every hernia the following parts are recognized: 1. The mouth (hernial opening), that is, the opening in the abdominal wall through which the viscera pass; 2, the hernial sac, that is, the sac-shaped, protruded peritoneum covered with skin or mucous membrane; 3, the contents (intestine, omentum, bladder, stomach, liver, uterus). The margin of the mouth of the hernia is termed the hernial ring. The hernial sac consists of a mouth, neck, body, and fundus. According to the contents of the hernia one speaks of an enterocele (intestinal hernia), epiplocele (omental hernia), gastrocele (gastric hernia), entero-epiplocele, cystocele, hysterocele (hernia of the uterus), hepatocele, oöpherocele. In addition to the essential contents hernias contain a serous fluid, hernial water.

With reference to the mobility of the hernial contents, they are classified as reducible (moveable, free), that is, they may be pushed through the hernial mouth into the abdominal cavity; and irreducible (immoveable), that is, a hernia that cannot be returned. The immobility is due,

either to adhesions between the hernial contents and the hernial sac, which is especially common in omental hernias (immobility of the omentum); or to incarceration (constriction, strangulation) of the prolapsed viscera, this is especially frequent in intestinal hernias.

With reference to the causes of hernias, they may be congenital or acquired (traumatic).

SYMPTOMS.—1. A reducible hernia is characterized by a large or small hernial swelling which occupies a characteristic seat in the umbilical or inguinal region, etc. The swelling is painless, is not characterized by a rise of temperature, and has a soft peculiar consistence ; the skin is moveable on the surface, occasionally one may easily palpate intestinal loops or pieces of omentum at its base. Percussion occasionally gives a tympanitic sound (air in the intestinal loops); on auscultation one can occasionally hear rumbling or gurgling peristaltic sounds. On pressure the swelling becomes smaller and finally entirely disappears in the abdominal cavity. Palpation of the abdominal wall reveals the hernial mouth, it varies in size from a pea to that of one's fist; in form it is round, oval or elongated, whenever a hernia has existed for a long time the free margin of ring becomes firm and tendinous. In rare cases the abdominal sac becomes ossified in cattle.

2. Incarcerated hernia, especially in horses, is first recognized by colic (strangulated inguinal hernia of stallions); in dogs and swine one further observes vomiting, and even stercoraceous vomiting; constipation is present in all animals. On local examination one finds an inflammatory swelling at the seat of the hernial sac ; attempts to return the hernial contents are unsuccessful.

TREATMENT.—One must differentiate between the treatment of a reducible and an irreducible hernia ; the reducible form may receive either provisional (palliative) or definitive (radical) treatment. It should also be observed that many forms of hernia, especially those of the umbilical and ventral regions in horses and cattle, heal spontaneously (cicatrization). On the other hand, many forms with a very

wide mouth (ventral hernia) are incurable, especially in horses and cattle. Finally, many forms of non-incarcerated hernias, especially those of the umbilicus, require no treatment as they do not usually result in diseased conditions (colic, etc.).

1. The palliative treatment of non-incarcerated hernia consists in the application of an abdominal bandage, this is especially useful for umbilical and ventral hernias of dogs, foals and mares. The prolapsed viscera are pressed back into the abdominal cavity by the abdominal bandage, this is followed by a gradual diminution in size of the hernial mouth.

Palliative treatment is further employed in the form of return of the hernial contents by means of pressure and reduction of the hernial sac by means of artificially developed inflammation and cicatricial formation in its vicinity. For this purpose the following agents have been employed: blisters (calcium dicromate 1–8 or 10), firing the skin of the hernial sac, applications of sulphuric acid, nitric acid, chromic acid, as well as subcutaneous injections of alcohol, salt, and other irritating materials. The efficiency of this method is still questionable. At any rate it is not without danger. Gangrenous necrosis of the skin with prolapse of the intestines has followed the application of acids; subcutaneous injections have been followed by severe phlegmons and fatal peritonitis. Other palliative remedies are ligation, clamping, and suturing of the hernial sac.

2. The radical operation consists in exposure of the hernial sac (herniotomy). The mouth of the hernia is sutured with, or without, subsequent extirpation of the hernial sac (inverted into the abdominal cavity). Herniotomy is the surest method of treatment of a hernia because it not only removes the hernial sac but obliterates the mouth. Experience has taught that mere suturing, clamping, or binding the hernial sac is occasionally followed later by the passage of viscera through the remaining hernial mouth, this results in the gradual formation of a new sac.

3. Treatment of an incarcerated hernia consists first in the return of the strangulated viscera (taxis) through manual reposition, dorsal position, combined attempts from without and inside the rectum, placing the hind limbs in a special position to favor enlargement of the inguinal ring, as well as deep narcosis of the animal by means of chloroform. If reposition is not successful by this method, the constricted hernial moth (implication of the tunica vaginalis) must be enlarged by means of a hernial incision (herniotomy), taxis may then be successfully employed. The return of the strangulated hernia must be preceded by careful disinfection, as well as resection of any necrotic portion (intestinal suture). In stallions, herniotomy of an incarcerated inguinal hernia is usually followed by castration with the use of clamps and the covered operation.

II. PROCIDENTIA. PROLAPSUS.

Definition.—Prolapsus (prolapse) is a free passage of viscera through natural or artificial body-openings without a covering of the skin or mucous membrane. As a rule the causes are traumatic in nature. Thus, rupture of the abdominal wall results in prolapse of the intestines and other abdominal viscera; severe efforts at abdominal pressure, prolapse of the rectum; stretching and relaxation of the uterine ligaments, prolapse of the vagina and uterus; penetrating thoracic wounds, prolapse of the lungs; severe wounds of the skull are followed by prolapse of the brain; bites of the eye, prolapse of the bulb; rupture of the vaginal wall, prolapse of the bladder; paralysis of the penis and tongue, proplase of these organs.

Prolapse should not be confused with eversion (inversion, inflexion) of a hollow organ (bladder, uterus), or with intussusception (invagination) of a section of the intestine or vagina into itself. Prolapsus vesicæ is a prolapse of the bladder through the ruptured vaginal floor into the vagina, or outwards through the vulva; inversio

vesicæ is an outward inversion of the bladder through the neck of the bladder and the urethra. In veterinary science the nature of prolapsus, inversion, and invagination is not always sharply distinguished. So-called prolapsus recti is often prolapse of the rectum with invagination; so-called prolapse of the uterus and vagina, an inversio uteri and vaginæ with prolapse.

SYMPTOMS.—The symptoms of prolapse are extremely variable according to the organs affected.

1. Prolapse of the intestines consists in the protrusion of portions of the small intestines, colon, and even cæcum, through penetrating abdominal wounds, through the inguinal canal after castration, or through a hernial ring after herniotomy. It is always a very dangerous accident. Reposition must be accompanied by careful disinfection of the prolapsed intestines, taxis is followed by accurate suturing, castration by the covered method may be necessary.

2. Prolapse of the omentum most often occurs after castration, or following perforating abdominal wounds. It is far less dangerous than prolapse of the intestines. Treatment consists in careful disinfection, ligation, incision of the stump, return of the stump, and careful suturing of the wound. Castration by the covered method may be employed.

3. Prolapse of the rectum is partly a prolapsus ani, partly a prolapsus recti, with or without invagination. It is a result of abdominal pressure from straining, chronic diarrhea, rough exploration, etc. It is most frequently observed in dogs, cats, and swine, less often in horses. The prognosis should be made with caution, reposition, regardless of sutures, is frequently of no permanent value, so that one must employ amputation of the prolapsed parts.

4. Prolapse of the vagina occurs in cattle as an inversion of a portion of the vagina (incomplete prolapse), less frequently in the form of an invagination of the entire vagina with a simultaneous prolapse (complete prolapse). It may follow traumatic influences as a result of parturition. A posterior displacement of the uterus when accompanied by atony of the uterine ligaments, so-called habitual prolapse, may occur in cows which occupy positions with the hind parts the lowest.

5. Prolapse of the uterus is especially common in cattle, it is caused by rough manipulations at the time of birth; inversion with prolapse is also due to continued straining. Reposition, and retention especially, is occasionally difficult, so that amputation is sometimes required.

6. Prolapse of the penis is observed in paralytic conditions, as well as in paraphimosis. Prolapse of the tongue is either the result of rupture of the muscle, or paralysis (it should not be confused with the ordinary blemish in which the tongue is protruded). Prolapse of the bulb is most often observed in dogs (pugs) as a result of bites; treatment consists in reposition or amputation. Prolapse of the membrana nictitans is observed in tetanus. In addition to these are inversion and prolapse of the bladder, prolapse the of pododerm, prolapse of the iris, prolapse of the posterior corneal membrane through a corneal ulcer (keratocele), forward protrusion of the cicatricial cornea (corneal staphyloma).

The following internal changes in position of viscera are of surgical importance: torsion and anteversion of the uterus in cattle, twisting of the left colon on its axis in horses. Twisting of the stomach on its axis is occasionally observed in dogs, as well as luxations and torsions of the spleen in swine. With reference to changes in position of the uterus, and abnormal positions of the fetus, see text-books on obstetrics.

DISEASES OF BONES.

1. BROKEN BONES. FRACTURES.

PRELIMINARY REMARKS ON ANATOMY AND PHYSIOLOGY.—**Normal bone is composed of three principal constituents: the periosteum, the genuine bone-substance (tela ossea), and the bone-marrow. From a surgical standpoint the periosteum is of greatest importance in diseases of bone, this is especially true of fractures. The bone-marrow (endosteum), from a standpoint of veterinary surgery, stands next in importance. In diseases of the bone the tela ossea plays a less important part.**

For an understanding of the processes of healing, as well as various pathological processes in the bone, it is necessary to have a knowledge of the physiological development as it occurs in the normal growth of bone. As a result of the embryological and histological investigations of Kölliker, Gegenbauer, Waldeyer, and others, it has been demonstrated that bone may develop from periosteum, bone-marrow, or cartilage. One distinguishes, then, a periosteal, a myelogenic or endosteal, and an enchondral formation of bone. The organs mentioned supply, first of all, a soft germ-tissue, the marrow-tissue (osteoid tissue) in which the OSTEOBLASTS, that is, the specific bone-forming cells, then develop. The most important processes are as follows:

1. Periosteal bone formation is similar to the perichondral form which occurs in the fetus, that is, it develops from the inner osteoblastic cell-layer of the periosteum (so-called cambium or formative layer); the outer layer of the periosteum has few vessels or cells, it is rich in connective-tissue fibers, and plays no part in the development of bone. The formative layer of the periosteum contains marrow-spaces which have a rich cellular and vascular supply. A part of the former are transformed into osteoblasts; calcium salts are deposited around them and there is formed lamellar-like bone-tissue in which these cellular elements are confined in sac-like cavities and are retained as so-called bone cells.

2. Myelogenic or endosteal bone formation follows in a similar manner, the boundary between the marrow and the tela ossea is first supplied with osteoid tissue from the bone-marrow, this is followed by the formation of osteoblasts and bone-tissue.

3. Enchondral bone formation is observed on the epiphyseal cartilage of fetal bones; it develops from the osteoblasts and marrow-cells of the marrow-cavities in the cartilage. If the epiphyseal symphisis is continually irritated (chronic inflammation, compound fractures, blows from sticks) developing bone becomes abnormally long (Bergman, Tillman, and others).

In contrast to the bone-forming activity of the osteoblasts, there stands the resorbing activity of the OSTEOCLASTS; this is constantly present in normal bone. The origin of these bone-solving, multinuclear, giant-cells has not yet been demonstrated by any method free from objection (descendants of the osteoblasts? the white blood-corpuscles? the endothelial cells of the vessels? the adventitia or perithelial cells?). According to Tillman the activity of the osteoclasts is as follows: apparently they cause a solution of the calcium salts of the bone by the formation of free carbonic acid, thus resorbing the osseous matrix, in this manner small cavities or lacunae are formed in the bone (lacunar bone resorption, Howship's lacunae).

NATURE AND CAUSES.—Broken bone or fracture is a division of the continuity of the bone; in contrast to a bone-wound the external skin usually remains intact.

The causes of fracture are either external or internal. Most fractures are due to external causes (kicks, blows, falls, contusions). One also differentiates between direct and indirect bone fractures. A direct fracture occurs at the seat of the trauma. An indirect fracture occurs at a distance from the seat of the traumatic injury. Contusion- and compression-fractures belong to the indirect form (fracture of the vertebræ from falling on the hind parts); this is also true of fractures due to torsion and bending (straining of the first phalanx when caught in the rails, fracture of the vertebræ when cast), and traction- or strain-fracture (fracture of the calcaneum due to pulling of the achilles tendon when falling upon the strongly flexed hind limb). Fracture by contrecoup or contra-fracture is classified among the indirect forms, it occurs according to the principle of contra-fissure (fracture of the sphenoid bone by falling on the mouth, fracture of the internal angle of the ilium by falling on the tuberosity of the ischium).

Fractures may occur in the absence of all external traumata, merely through internal causes, especially as a result of increased muscular contractions. So-called spontaneous bone-fracture is most frequently observed when casting horses; it is due not merely to falling, but occurs as a result of pronounced muscular contraction while the animal is lying or balancing; contraction of the longissimus dorsi results in a dorsal or lumbar fracture; severe exertion of the retained hind limb, fracture of the femur, tibia, or metatarsus; severe struggling against retention of the anterior limbs may result in a fracture of the scapula or humerus. Spontaneous bone-fractures occur even in horses that are standing; the lumbar vertebræ may be fractured by suddenly stopping or turning a horse (Trasbot), violent kicking with both hind feet (Haubner), while galloping (Wittman), when rising (Moussu); the humerus when traveling rapidly, sudden turning of the horse by the rider, and heavy pulls

(Flook, Penberthy, Ernes, Lagrifoul); the pelvis and tarsus by supporting the body weight on one hind limb when slipping (personal observations); other bones of the hind limbs as a result of severe contraction of the extensors when kicking (Joly); the pisiform bone in heavy draft-horses (Möller); the lumbar vertebræ, femur, and tibia during extraction of the teeth while the animal is standing (Eberlein).

In many cases neither external nor internal influences can be demonstrated as causes of bone-fracture. The so-called idiopatic fractures must be explained by an abnormal fragility of the bones (fragilitas ossium, osteopsathyrosis). Idiopathic fractures are not uncommon in horses and cattle. The fragility is due either to certain pathological conditions of the bones, especially osteomalacia, rachitis, rarefying ostitis, bone caries, sarcoma (melanosarcoma), and tuberculosis; or to certain predisposing influences, old age (senile atrophy), standing in the stall for a long time when convalescent from some disease (atrophy of inactivity); extreme youth (juvenile bones, intrauterine fractures); disease of the nervous system, especially that form which occasionally follows neurotomy (trophoneurotic bone-atrophy); restricted mobility in the joints (anchylosis of the vertebral column in the horse sometimes results in fracture of the vertebræ). Occasionally no cause for the fracture can be found, regardless of a careful examination. These cases one must account for by individual variations in the solidity and elasticity of the bones of different animals. A hereditary fragility of the foals of certain mares has also been observed, it is characterized by numerous fractures.

ABNORMAL FRAGILITY.—Without the acceptance of this condition many cases in veterinary practice are unexplainable. This is especially true of those fractures of the spinal column in horses, which, regardless of the most careful precautions, frequently occur when the animal is being cast: they are more common than is generally supposed or published. Experience has shown that old horses are especially predisposed to this form of fracture (casting for operations on the teeth, extirpation of the lateral cartilage). If

these fractures are less frequently observed in many countries and clinics than in others, it is, according to my judgment, due not only to the various methods of casting but to the differences of race and conditions of nourishment. Further, this class includes those cases of multiple fracture in one and the same animal. In a cow affected with osteomalacia the pelvis was fractured no less than fifteen times (Maris). In a sound horse that suddenly became lame after a few jumps when galloping, the sesamoid bones were fractured in all four limbs (Rutherford). A stallion fractured both femurs during a castration (Haselbach). One horse fractured all four of the second phalanges at the same time (Henon); another fractured three suffraginal bones (Röder); many others have fractured two of the first or second phalanges (Wendworth, Möller, personal observations). An abnormal fragility of the ribs and vertebræ has also been repeatedly observed in horses (Degive, Thümmler, and others).

The causes of abnormal fragility of bones in old horses are usually considered to be a senile atrophy of the bones, and in young horses a rarefying ostitis. Recent investigations by French veterinarians have resulted in an explanation of this problem. Joly and Vivien (Recueil. 1901) found the typical changes of rarefying ostitis in a first phalanx that was fractured while the animal was going at an ordinary trot. On macroscopic examination a rapid, artificial solution of the lime salts of the fractured bone was easily recognized when compared with the corresponding bone of the other foot. Microscopic examination of the fractured bones revealed numerous and extensive dilitations of the Haversion canals (rarefying osititis); the articular cartilage was secondarily involved (atrophy, penetration of the cartilage with vascular loops). In two cases of fracture of the lumbar vertebræ in horses Jacoulet and Vivien found rarefying ostitis with vascular dilitation (redness), liquefaction of the fatty substance (float in water), and porosity.

CLASSIFICATION.—From a practical standpoint the most important division is into simple (subcutaneous) and compound (open) fractures. Simple, subcutaneous fracture is a fracture of the bone without an injury to the skin. In contrast to this a compound fracture is accompanied by a skin-wound, so that the bone is exposed and entrance of infection is possible.

Further, a classification into complete and incomplete fractures is important. In the former the bone is broken across its entire diameter at the point of fracture, so that the ends are not attached to each other. The separation is only partial in incomplete fracture, there is only a cleft or

fissure, that is, a split in the bone (fissure, longitudinal fracture), or an infraction or bending (infraction, impression, depression, subperiosteal fracture, green-stick fracture). Fissures most frequently occur on the first phalanx and on the tibia ; infractions, on the ribs; impressions, on the bones of the skull. Fissures are often transformed later into compound fractures.

According to the direction of the broken line one distinguishes transverse fractures (fractura transversa); oblique fractures (fractura obliqua); longitudinal fractures (fractura longitudinalis); spiral fractures with a wound-line that takes the form of a screw ; fractures in the form of the mouth-piece of a clarionett (fracture en bec de flute); Y-shaped fractures; and T-shaped fractures (on the first phalanx).

According to the position of the broken fragments in complete fractures various kinds of dislocation are recognized ; namely, dislocatio ad axin (angular fracture); ad latus (lateral or transverse displacement); ad peripheram (rotation); ad longitudinam, either with impaction (shortening), or separation (increase in length). Impaction is likewise a form of longitudinal dislocation with contraction ; diastasis is an opposite condition.

Further, in contrast to a simple fracture, in which the bone is broken only once, one speaks of a multiple fracture (fractura multiplex), double fracture, triple fracture, etc. They are observed especially on the first and second phalanges and on the epiphyseal ends. When the bone is broken into small fragments it is termed a comminuted or splinter-fracture (fractura comminuta); when a splinter-fracture is characterized by complete crushing of the bone it is termed a conquassion fracture (fractura conquassata). The latter occurs, for example, in vertebral fractures when casting horses.

Partial bone fracture, which is not uncommon in veterinary practice, is of importance. Certain portions of the bone are broken, not the entire bone. These occur in the following places : on the lateral tubercles and tuberosities of the

humerus; on the trocanters of the femur; the spine of the scapula; and the oblique and transverse processes of the vertebræ. especiailly the cervical and lumbar vertebræ.

FISSURES.—These are of great practical importance, because in horses their occurrence is especially frequent, diagnosis is very difficult, and many cases are finally transformed into complete fractures. In addition to the first phalanx and tibia, fissures are found in the vertebræ, in the scapula, humerus, radius, metacarpus and metatarsus, femur, second phalanx, os pedis, in the ulna, etc. Fissures are frequent in the vicinity of gun-shot-fractures (penetrating shots). A peculiarity of fissures is that after a certain time, often several days, they are transformed into complete fractures, this has been repeatedly observed in practice. Usually it is unexpected, and occurs during the night, when the animal is rising or lying down, on raising the hoof to be shod, etc., this is especially true of the tibia and first phalanx. Fractures due to kicks on the inner side of the tibia in the horse may be transformed into complete fractures after weeks or months (in two cases one went for seventy days, the other for one hundred twenty-eight days). Also in other bones, fractures occur which are transformed after a time into the complete form. Especially remarkable are those cases of fissured vertebrae in the horse which occur after casting or falling, complete fracture taking place after several hours or a few days, even after weeks. They are characterized by sudden paralysis of the hind parts. Occasionally these occur in horses that have been used for saddle or driving purposes regardless of the fissure. According to the records of the veterinary literature cases of this kind are not uncommon (Spinola, Dieckerhoff, Möller, Straube, Gützlaff, Flatten, Würgler, personal observations). I have, for example, observed that after the casting of a thorough-bred stallion complete fracture developed from a fissure after four weeks (twenty-nine days). During this time the animal was in perfect health and stood on all four limbs. In similar cases fissures in the horse have developed into fractures after a long time, even weeks; fractures of the metacarpus (Bauer), humerus (Philippi, personal observations), and radius (Freer, Günther, Schmid). For reference to old fissures from a forensic standpoint see page 210.

FREQUENCY AND OCCURRENCE.—Fractures of bone most often occur in horses and dogs; they are not infrequent in cattle, birds and swine. In cats fractures are relatively uncommon; because of their elasticity they may fall a considerable distance (several feet) without being injured. In the horse the ordinary causes are falls, running into objects,

collisions, kicks from horses, casting; in dogs, kicks, bites, being run over, squeezed, falls, and stones. Bone-fractures in horses and dogs are most often seen in large cities; in the former it is due to slipping and falling on hard smooth pavements, especially on asphalt when it is covered with smooth wet ice; dogs are run over with street cars, hacks, and other vehicles. According to my experience in Berlin dogs suffer most often from fractures on Sundays (picnic parties), for that reason Monday's clinic is supplied with an abundance of material; the same condition follows any interruption in traffic. Fractures in war are usually caused by projectiles.

The statistics of the Prussian Army afford valuable material relative to the frequency of fractures in horses. Among 30,000 horses, 400 fractures a year occur during times of peace. The total number of fractures, covering a period of five years (1891–1895) in the Prussian Army was 2000. The following regions are most often affected: pelvis, tibia, first phalanx, bones of the head, the radius, the metatarsus, and the vertebrae. Fractures of the tibia, pelvis, and the first phalanx cover about fifty per cent of all fractures in the horse.

With reference to the frequency of fractures in the dog, my own published statistics covering a period of nine years (1886–1894) and 70,000 diseased dogs, show the following results: about 1700 (1693) suffered from fracture, this amounts to 2.3 per cent of the total number of diseased dogs. In Berlin, one in forty of all diseased dogs suffers from fracture. Luxations, in contrast to fractures, are less frequent in dogs, occurring about one fifth as often (I have seen only 344 cases in all, equal to .5 per cent). According to my experience the most frequent fractures in the dog are of the femur (17 per cent), the radius and ulna (15 per cent), the tibia and fibula (13 per cent), and the humerus (5 per cent). In the dog ninety per cent of all fractures involve the bones of the extremities. The following bones are least often fractured:

sternum, bones of the cranium, the vertebral column, the patella, the ribs, and the scapula.

In cattle, fractures most often involve the head of the femur, pelvis, scapula, tibia, metatarsus, and bones of the tail. Recorded statistics are wanting.

With reference to the frequency of fractures in swine, information is found in the work of Charpentier and Lafourcade. Fifteen per cent of all slaughtered swine show fractures of the ribs in various stages of healing. Transportation in narrow quarters explains this condition.

Frequency of fractures in birds is furnished by the statistics of Larcher who has treated 250 cases. According to Cadiot the following bones are most often fractured: humerus, tibia and femur; the radius, ulna, scapula, and ribs are less frequently fractured. I, myself, have treated 137 fractures in birds, 64 were in large birds (hens, swans, parrots), and 73 in small (song and ornamental birds). Wings and limbs were most often fractured.

STATISTICS.—1. Bartke has collected the following statistics on the horse from the records of the Prussian Army: in a period covering ten years from 1886–1895, of 280,000 diseased animals, bone fracture occurred in 3473. Of 3000 recorded fractures, 1800—equal to 60 per cent—involved the limbs; 1000—equal to 30 per cent—involved the body and vertebral column; 200—equal to 10 per cent—involved the bones of the head. Individual fractures were as follows:

Tibia	557 times	18 per cent.
Pelvis	491 "	16 "
First Phalanx	404 "	13 "
Radius	239 "	8 "
Cervical Vertebræ	237 "	8 "
Metacarpus	210 "	7 "
Lumbar Vertebræ	87 "	3 "
Dorsal Vertebræ	75 "	2.5 "
Humerus	72 "	2.5 "
Ulna	70 "	2.5 "
Ribs	68 "	2 "
Femur	59 "	2 "
Second Phalanx	53 "	2 "
Third Phalanx	52 "	2 "
Occipital Bone	52 "	2 "

Sphenoid Bone	43 times	1.5 per cent.
Scapula	35 "	1 "
Frontal Bone	33 "	1 "
Superior Maxilla	32 "	1 "
Inferior Maxilla	31 "	1 "

In the years 1895–1902 at the Surgical Clinic of the Berlin Veterinary School I treated 308 fractures from a total of 7000 diseased horses. Of these, 103 involved the pelvis, 43 the bones of the head, 38 the first phalanx, 21 the vertebræ, 14 the scapula, 14 the humerus, 13 the tibia, 12 the second phalanx, 12 the femur, 9 the third phalanx, 6 the navicular bone, 5 the ulna, 4 the ribs, 4 the radius, 3 the metatarsus, 2 the sacrum, 1 the tarsus, 1 the carpus, 1 the patella, and 1 the sternum.

According to Cadiot (clinic in Alfort) 159 fractures of the extremities of the horse were distributed as follows: tibia 32, pelvis 30, first phalanx 24, radius 17, metacarpus 15, humerus 13, femur and ulna 6, scapula 5, second phalanx 4, carpus 3, third phalanx 2, calcaneum and trochlea 1. Mörkeberg at the Copenhagen Clinic has treated 69 fractures in the horse in the years 1896–1900. The fractures were distributed as follows: pelvis 31, first, second, and third phalanges 15, bones of the head 7, ribs 5 times. According to Verlinde 42 fractures occurred in twelve years in three Belgian Cavalry Regiments. They were distributed as follows: femur 21, third phalanx 2, navicular, first phalanx, and second phalanx 1.

2. I have observed 1693 cases of fractures in dogs (548 in the hospital clinic, 1145 in the polyclinic). 1145 fractures in the polyclinic were distributed as follows: head 22, trunk 60, anterior limbs 434, posterior limbs 537. Individual fractures compiled from 915 cases were distributed as follows:

		per cent
Femur	188 times	17.0
Radius and Ulna	170 "	15.0
Tibia and Fibula	145 "	13.0
Humerus	58 "	5.0
Metatarsus	47 "	4.0
Metacarpus	40 "	3.5
Carpus	38 "	3.0
Anterior Phalanges	39 "	3.0
Posterior Phalanges	35 "	3.0
Pelvis	30 "	2.5
Tarsus	27 "	2.5
Coccygeal Vertebræ	26 "	2.5
Scapula	17 "	1.5
Ribs	16 "	1.5
Inferior Maxilla	16 "	1.5
Lumbar Vertebræ	11 "	1.0
Dorsal Vertebræ	5 "	0.5
Patella	2 "	0.2

With reference to the resistance (resistance to pressure) of bones in different races and species, information has been supplied by the recent investigations of Hoffman (Berl. tieraertl. Wochenschr. 1901). Of the long bones of the extremities in the horse, the metatarsus was the most resistant. A difference in breed was not observed; age, on the other hand, resulted in variations. The bones of cattle were far less resistant than those of horses.

SYMPTOMS AND DIAGNOSIS — The symptoms are extremely variable according to the nature of the fracture. While the complete fractures, especially the complicated, are easily recognized, the diagnosis of fissures is often very difficult. In general the following symptoms are characteristic of fractures in the domestic animals.

1. Inability to support weight, as well as pain when the animal is at rest or in motion, are the first visible symptoms of fracture of the bones of the extremities. Any sudden high-grade lameness in the horse, standing and traveling on three limbs, should cause suspicion of fracture. Horses and dogs stand and travel upon three limbs; horses either refuse to move or travel with great difficulty; palpation causes crying in dogs. Many fissures are characterized by a line of pain along that of the fracture (pain-line in fissures of the first phalanx). Pain and disturbed function are often absent in fractures of the pelvis and ribs, in many fractures of the skull, as well as in fissures of the vertebræ. Total paraplegia and anesthesia are observed in fractures of the vertebral column.

2. Abnormal mobility of the broken bones and limbs at the point of fracture is the most characteristic symptom. Abnormal mobility may be visible (pendulant position of the limbs, abnormal positions and relations), it may also be determined by palpation (fixation of the superior and inferior fractured ends). Abnormal mobility is usually absent in all incomplete fractures, as well as in fractures of the pelvis and vertebral column; in other cases the normal mobility of the limb may be restricted or suspended (impaction).

3. Crepitation at the point of fracture, that is, a rough rubbing sound on palpation and passive movements of the fragments, is very characteristic; this is often a direct

pathognomonic sign of the existence of a fracture, especially a splinter-fracture. (One should be careful not to confuse this with arthritis and tendovaginitis crepitans). Crepitation fails in all incomplete fractures of the vertebral column, and in many fractures of the pelvis, as well as in marked dislocation of the fragments.

4. Swelling in the vicinity of the broken ends is characteristic of simple fractures, it is due to rupture and subsequent hemorrhage in the adjacent soft tissues. Callus formation results in swelling in old and complicated fractures, especially when there is a phlegmonous inflammation of the soft tissues. Swelling is often absent in incomplete fractures.

5. Injury to the skin, as well as a subsequent suppuration and fistula formation occurs only in compound fractures; subcutaneous fractures seldom result in suppuration, it may occur through the blood by means of a pyemic infection (strangles).

6. Derangement of the general condition seldom occurs in simple fractures; subcutaneous fractures that are characterized by severe hemorrhage and injury to the soft tissues may lead to a slight rise of temperature without other general derangement. The rise of temperature, which also occurs in animals, is termed an aseptic fever (in man subcutaneous fractures are usually followed by a temperature of 38.5–39.5). This is explained by the presence of a ferment-like febrifacient formed from degenerated blood-corpuscles at the seat of fracture, this material is resorbed (v. Bergmann, v. Bruns, and others). Fever which follows complicated fractures, on the other hand, is usually septic because of the presence of pus cocci. Rupture of large blood-vessels by fragments of bones is followed by symptoms of internal hemorrhage, this is especially true of pelvic fractures; severe crushing of the bone-marrow is followed by fat-emboli in the lungs and brain. In man, in addition to lipuria, albumenuria, and cylindruria· resulting from fracture, there have been observed brown cylinders, increase in the urobilin contents of the urine, and even hematogenous icterus as a result of the absorption of coloring matter from degenerated blood.

7. For many fractures certain specific individual symptoms are of diagnostic importance. Fracture of the nasal bones produces visible impressions, epistaxis, stenotic sounds, and even permanent stenosis with dyspnea. Costal fractures lead to hemoptysis, pneumonia, pleurisy, and injuries to the intercostal arteries. Fracture of the sphenoid bone, under certain circumstances, results in amaurosis, and dysphagia; fracture of the bones around the eye, phlegmon of the orbit; fracture of the hyoid bone and maxillary bones, glossolysis, difficult mastication, and dysphagia. Chronic catarrh of the guttural pouches has been observed after fracture of the hyoid bone (Siedamgrotzky, Rupprecht). Severe fractures of the cranial bones are followed by insensibility, nystagmus, hemorrhage from the ear (fracture of the base of the skull and the temporal bone), as well as fatal paralysis of the brain; fracture of the cervical vertebræ, by paralysis of the diaphragm; fracture of the dorsal or lumbar vertebræ, by fatal paraplegia, this is introduced by a sharply circumscribed motor and sensory paralysis, later it gradually becomes generalized. Healed fractures in the vertebral column produce deformities through the formation of anchylosis and synarthrosis (torticollis, lordosis, kyphosis, scoliosis). Fractures of the last rib in the horse have occasionally resulted in injuries to the stomach and diaphragm (Grosswendt and others). Paralysis of the larynx resulted from a fracture of the first left rib in a dog (Frick). Laceration of the obturator artery is common in fractures of the pelvis; it results in internal hemorrhage. Fractures in the vicinity of the foramen ovale may result in permanent paralysis of the obturator, which leads to paralysis and atrophy of the adductors; the nerve becomes involved in the callus (Thommassen). Fracture of the external angle of the ilium in a horse resulted in fatal laceration of the circumflex artery (Kemp). Fatal laceration of the internal thoracic artery in a horse has resulted from fracture of

the sternum (Sand). In another horse with fracture of the eighth and ninth dorsal vertebræ there was pronounced perspiration of the anterior regions which stopped in the immediate vicinity of the fracture (Bourgoin). In other horses with fractures of the vertebræ there are girth-shaped areas of perspiration in the lumbar region (Röder; personal observations). A horse with fracture of the right external angle of the ilium showed severe and permanent perspiration, as well as non-sensitiveness of the skin beneath the right hip (Delacroix).

RÖNTGEN RAYS.—The use of Röntgen Rays which has recently become of diagnostic value in the illumination of fractures in man has been experimentally employed in veterinary science (Bayer, Eberlein, Pfeiffer, Jensen, Hoffman, Tröster, Krüger, and others). In the latter case it is not of general practical importance. The application of rays in living animals is frequently associated with great difficulties on account of the restlessnes of the animal. In addition to this is the high price of the apparatus (a Voltohm-apparatus for illumination of the horse costs 2500–2800 marks), as well as the complexity of manipulation. On the other hand, Röntgen rays may be employed in clinics, especially upon small animals (foreign bodies), as well as for the diagnosis of fissures and fractures of the bones of the extremities (first, second, and third phalanges). (For details concerning the application of Röntgen Rays in veterinary science see my "Chirurgische Diagnostik der Krankheiten des Pferdes." 1902).

PROGNOSIS.—When judging a fracture with reference to its healing or non-healing propensities the following factors are brought into consideration:

1. The species of the animal is of first importance in giving a prognosis. In horses and cattle fractures usually heal more slowly than in the smaller animals. The cause is due, on the one side, to the fact that it is either very difficult or impossible to apply a bandage on a horse or a cow, the attempts at reposition and retention of the fragments are frustrated. On the other hand, as a result

of standing for a long time upon three limbs, severe inflammation of the pododerm often develops in horses and cattle; it begins with increased arterial pulsation and severe pain, and terminates with sinking of the os pedis and necrosis of the pododerm with a subsequent septicemia (pressure laminitis). Remaining for a long time in the recumbent position also produces contusions and decubital gangrene of the skin with general sepsis because of the great body-weight of these animals. According to the experience of the Prussian Army only 20 to 25 per cent of all bone-fractures in the horse are curable; of 3473 covering a period of ten years from 1886–1895, 744 healed: equal to 22 per cent. On the other hand, according to my experience among dogs, the total number of healed fractures amounts to about 85 per cent. The prognosis of fractures in the dog, therefore, is four times as favorable as in the horse. The percentage of healing in birds is still higher. Also in swine, rib-fractures especially, appear to heal very rapidly. The time required for fractures to healin horses and cattle averages from one to three months; in the dog and sheep, three to four weeks; in birds, fourteen days.

2. The bone itself, from a prognostic standpoint, is of great importance; one bone may heal very readily, another with great difficulty, many seldom heal. In fully developed horses and cattle the following fractures are usually incurable: fractures of the cervical vertebræ, dorsal vertebræ, and lumbar vertebræ when the body or arch is involved and leads to injury of the spinal marrow; complicated (in most cases the simple also) fractures of the femur, tibia, scapula, humerus, and radius; comminuted fractures of the first and second phalanges, as well as many fractures of the pelvis. Fractures of the metacarpus and metatarsus heal with great difficulty. The following, however, are relatively cureable: fissures, simple fractures of the ribs, fractures of the external angle of the ilium, those in the vicinity of the eye, simple fractures of the first and second phalanges, and caudal vertebræ, as well as the vertebral processes.

3. The kind of fracture is also of great importance from a prognostic standpoint. In general the following are unfavorable: comminuted fracture, splinter and complicated fractures, as well as those which involve a joint or occur in its immediate vicinity (glenoid cavity). Simple fractures, on the other hand, are relatively favorable. The prognosis is also unfavorable in non-recent fractures which are first brought for treatment some time after they occurred. Fractures of the diaphyses heal more readily than those of the epiphyses; transverse fractures more readily than the oblique. Healing is delayed when the patient suffers from internal disease. Fractures in the vicinity of the joint occasionally lead to anchylosis (fetlock-joint, coronary-joint, pedal-joint). The prognosis of partial fractures is especially favorable, for example, fracture of the lateral tuberosity of the humerus, or the oblique processes of the cervical vertebræ. In general, fissures are more favorable than complete fractures. The prognosis of many fissures, on the other hand, has been found to be unfavorable. The process of healing seems to be very slow, especially in fissures of the first phalanx of the horse (six to twelve weeks and over). Fissures of the vertebral bodies are mainly incurable.

4. The age of the animal has an influence on the prognosis, experience has shown that the healing of bones proceeds more slowly in old animals than in young. Young animals can remain standing or recumbent, without danger, for a longer time than those advanced in years.

Finally, in horses and cattle, in addition to the points already discussed, one must decide whether the patient is worth treatment from an economic standpoint, or whether it would not be better to slaughter the animal.

CURABILITY OR INCURABILITY OF A FRACTURE.—The answer to this question belongs to one of the most difficult problems with which the practicing veterinarian has to deal. Because the question must frequently receive an immediate answer (on the race-track for instance) a careful consideration of the previously considered influences is necessary. In particular, one must not forget to compare the value of the

patient with the cost of treatment—that is, the resulting permanent diminution in the usefulness of the animal. In doubtful cases, especially in cattle, one should advise slaughter. In certain cases, when the patient is a valuable breeding-animal, treatment until birth of the young may be advised. Cows advanced in pregnancy may be killed when suffering from incurable fractures of the pelvis: perform laparotomy immediately after slaughter and extract the young through an incision in the uterus (Cesarian section).

From a forensic standpoint also, it is often difficult to render an opinion with reference to the curability of a fracture. In Prussia many verdicts are rendered through the knackers privilege by which the knacker has the right to reclaim for himself incurable cattle. Occasionally these questions must be decided with careful reference to the existing conditions, especially to the seat and kind of fracture. In general the previously explained conditions are sufficient. One's verdict is controlled by the average statistics furnished by experience ("as a rule" curable or incurable).

It has been observed many times in horses and cattle, that, exceptionally, fractures with a very unfavorable prognosis may heal. Finally, not all cases recorded in veterinary literature are free from exception: Pöschl healed a complicated fracture of the inferior third of the femur in a thorough-bred stallion in eight weeks (?). A complicated fracture of the patella, which was broken in three pieces, healed in a horse in two months with the formation of a bony callus; lameness remained which was severe when the animal trotted and slight during walking movements (Andrieu). A pelvic fracture, which involved fracture and displacement of the acetabulum healed in a cow (Berdez). A separation of the pubic symphysis after difficult parturition in a cow healed in four weeks, and twice afterwards the cow gave birth to calves (Henninger). A bilateral complicated fracture of both inferior maxillæ at the interdental space healed in fifty days in a horse (Passerini). A fracture of the trocanter of the femur healed in a two-year-old foal (Neuberger). I, myself, have observed healing in two different cases of fracture of the lateral tuberosity of the humerus, as well as in two fractures of the scapula, in fully developed horses. A transverse fracture of the metacarpus of the horse healed in sixty-six days (Pujos); complete healing occurred in a similar manner in fracture of the radius of a horse (Schafer, Salchow, and others). In a four-year-old colt healing of a complicated fracture of the femur took place in the slings in four months without the use of a bandage; a piece of the middle trocanter was discharged from an abscess (Bräuer). A fracture of the metatarsus in a colt four days old healed under a plaster bandage in five weeks, similar healing occurred in a fracture of the radius and ulna in a foal eight weeks old (Frank).

PROCESS OF HEALING IN SIMPLE BONE FRACTURES.—

Healing of simple subcutaneous bone-fractures occurs through an aseptic inflammation very analogous to that of primary healing of skin wounds. The uniting of the broken ends of bone is due, partly to the regenerative activity of the periosteum, partly to that of the bone-marrow. The essential portions involved in callus formation are only the connective-tissue, soft portions of the bone (periosteum, endosteum); the tela ossea plays no part. Also the effused blood at the point of fracture, as well as the neighboring soft tissues are not involved in the process of healing. The union of the fragments follows the formation of granulation-tissue, which subsequently ossifies, the so-called callus, the granulation-tissue is formed from the periosteum and bone-marrow. The bone-callus is the product of an ossifying periostitis and osteomyelitis. In this formation one distinguishes various forms of callus :

1. The external callus or periosteal callus is due to the activity of the osteoblasts situated in the deep layer of the periosteum.

2. The inner callus or marrow callus (endosteal callus, myelogenous callus) is an analogous product of the osteoblasts of the bone-marrow.

3. The middle or intermediate callus lies midway between the external and inner callus, and is considered as principally a continuation of the external callus, secondarily a product of the vessels of the Haversian canals (endothelial proliferation).

Finally, one distinguishes between a provisional and definitive callus. The provisional callus forms a relatively soft, spongy, extremely voluminous, newly-formed mass of bone. The definitive callus is formed later from the provisional callus as a hard, small, bony cicatrix.

Microscopic Changes of Callus Formation. According to histological and experimental investigations especially those of Virchow, Billroth, v. Volkmann, P. Bruns, Ziegler, and others the following changes occur : as in primary aseptic healing of wounds, there first occurs a cellular infiltration at the seat of fracture, as well as

the formation of a cellular and highly vascular embryonic or granulation-tissue (the callus); this proceeds from the periosteum as well as from the bone-marrow. During the process two phases are recognized: namely, the stage of ossification of the callus, and the stage of retrogression of the callus.

1. Ossification of the callus, the result of the ossifying periositis and osteomyelitis, proceeds, according to recent investigations, as follows: a cartilaginous callus is first formed from the inner layer of the periosteum, this is ossified as the result of a direct transformation of the cartilage into bone. (The osteoblasts play only a secondary role in this process). Within three or four days after the fracture small foci of osteoid tissue begin to form in the embryonic tissue in the vicinity of the fracture, they form a network of osseous trabeculæ with inclosed marrow cavities. In the second week the periosteal callus is a reticulated and tolerably soft tissue. From the end of the third week it develops into a firm, spongy callus-substance, rich in marrow, the provisional callus.

2 Retrogression of the callus begins in the fourth to the fifth week with obliteration of the newly-formed vessels. The resorbing activity of the osteoclasts (CO_2) liquefies the bone in the form of small spaces. Small foci of necrosis occur in simple bone-fractures as a result of derangements in the circulation at the line of fracture and its immediate vicinity, this necrosis must also be removed by lacunar resorption. At the same time the soft and uneven provisional callus is reduced to a hard, smooth, bone-cicatrix—the definitive callus—so that the previously thickened surface of the bone is apparently smooth again at the point of fracture, and the bone-cicatrix can hardly be seen, or recognized by palpation.

Callus formation is assisted by the administration of small doses of phosphorus (horse, centigram; dog, milligram). These small, continually administered doses of phosphorus produce a specific formative stimulus on the bone-tissue which results in an acceleration of its

growth. The exact changes which occur have been experimentally demonstrated by Wegener (Virchow's Archiv. 1872) through the continual feeding for months of milligram doses of phosphorus to young rabbits, hens, cats, dogs, and calves, as well as to adult animals. The following are the changes which occur: at areas where the cartilage normally developed into reticulated spongy substance, with abundant red marrow-tissue and rich blood-supply, there was formed compact, firm and hard bone-tissue with rapid transformation of cartilage to bone-cells; this was especially true of the long bones, vertebræ, ribs, pelvis, and the bones of the carpus and tarsus. The cause is due to a narrowing (schlerosis) of the smallest bone-canals (canaliculi); the result is a thick, firm, schlerotic bone-cortex. The development of the periosteum is also accelerated, the product, likewise, of a firm schlerosis. The intermediate epiphyseal cartilage undergoes more rapid ossification. Finally, the marrow cavities become stenosed and eventually disappear. Wegener's theory was investigated by Kissel (Virchow's Archiv. 1896); it was confirmed, however, by Stubenrauch (Berlin Surgical Congress 1900).

ABNORMAL CALLUS FORMATION.—1. Retardation of the previously described callus formation results from splintering of the bone, pronounced dislocation of the broken ends, interposition of the soft tissues, continued movement of the broken fragments (faulty bandage or lack of bandage), general diseases (osteomalacia, rachitis, infectious diseases, constitutional weakness), as well as infection of the broken areas (compare with healing of compound fractures). Subcutaneous splinter-fractures usually heal, small splinters may even be completely resorbed, necrosis occurs only as a result of subsequent infection (formation of a sequester).

When callus formation fails to produce firm union between the fragments, there exists a so-called false joint (pseudo-arthrosis), that is, a permanent moveable union between pieces of bone. This is especially observed on the head and neck of the femur, on the first phalanx, and on the posterior false ribs.

2. A callus which is abnormally large is termed a hypertrophic callus or callus luxurians. Hypertrophic cicatrix and callus luxurians correspond to excessive wound granulations; the so-called callus tumors have their analogues in the keloids and are usually osteomata or enchondromata, seldom osteosarcomata. When two bones

lying parallel to each other are firmly united by a callus formation, as is observed in the fracture of two ribs, there exists a synostosis. The bony, immobile union of two bones in a joint is termed anchylosis (anchylosis ossea). If the callus is not composed of bone-tissue, but of connective tissue, failure of ossification of the periosteal and myelogenous germinal tissue, it is termed a callus fibrosus. This is observed in the fracture of short, non-vascular bones, especially the patella, navicular bone, sesamoids, the olecranon, calcaneum, pisiform bone, the body and coronoid process of the interior maxilla, and the false ribs.

TERMINATION OF FISSURES AND FRACTURES OF LONG STANDING.—In the light of previous statements it is not difficult to imagine a fresh fracture resulting from an old fissure. For a forensic verdict it should be remembered that a fracture is preceded by an old fissure or fracture only when granulation-tissue or callus formation is present at the margin of, or in the vicinity of the fracture. The age is determined according to the condition of the callus (see above). Fresh fissures and fractures present no callus formation but hemorrhage, and the appearance of a fresh, aseptic inflammation. It is further observed that a fissure, sometimes very early, at other times only after a long period, may be transformed into a fracture. The smooth or uneven condition of the broken surfaces is of slight importance for the determination of the age of a fracture. A smooth broken surface, without other symptoms, does not indicate an old fracture; experience has shown that the surface, and edges of the broken surface may be worn smooth within the first half hour after the occurrence of the fracture (Günther). Trasbot treated a case of fracture of the tibia in a horse which first became apparent seven days after the occurrence of the fissure; a two or three mm. thick layer of young, very vascular, spongy bone-tissue was present on the broken ends. The bone-marrow was strongly injected, the compact bone-tissue could be easily cut. On microscopic examination the Haversian canals were found dilated and filled with round-cells. I investigated a case of fissure of the vertebra in a horse in which only soft granulation-tissue had formed at the seat of fracture after twenty-nine days, there was no callus formation.

PROCESS OF HEALING IN COMPLICATED BONE FRACTURES.—While the simple, subcutaneous bone-fractures heal per prima through an aseptic ossifying periostitis and osteomyelitis, complicated fractures lead to suppuration of the broken ends with callus formation. The prognosis of a complicated fracture depends upon the following conditions: duration of the

active influence of the pus-bacteria, age of the fracture, the extent of injury to the skin and surrounding soft tissues, as well as the extent of bone-splintering. With slight injury to the skin and soft tissues combined with careful disinfection of the wound, healing proceeds nearly as fast as in simple bone-fractures. With reference to the severity of a complicated fracture, the splintering is of less importance than the degree of injury to the soft tissues. A smooth fracture without splintering of the bone, but with a large skin-wound and extensive injury to the soft tissues is far more severe than extensive splintering with only slight injury to the soft parts (Tillmanns).

The local changes in the broken area of a complicated fracture, consist, in addition to the changes described under callus formation, in inflammatory swelling, suppuration, burrowing of pus, phlegmon, phlebitis, lymphangitis, septic processes, ichorous changes in the soft tissues, suppurative periostitis and osteomyelitis, necrosis of the bone (sequestration) and fistula formation; as a result of general infection septicemia and pyemia may follow.

TREATMENT OF SIMPLE BONE-FRACTURES.—The first surgical problem consists in reposition (reduction) that is, rearrangement and replacement of the dislocated ends in their normal position by means of a pull (extension) and a counter-pull (contra-extension); the second consists in retention, that is, fixation of the arranged fragments by means of a bandage. Callus formation only follows accurate reposition and complete rest for the broken ends. In many of the large animals, and in many fractures (ribs, pelvis, heads of bones), it is impossible to fulfill both conditions; certain fractures, however, heal in the absence of reposition and retention simply through natural healing, this is especially true of rib-fractures and many fractures of the pelvis. In small animals, on the other hand, especially in dogs, reposition and bandaging is usually possible.

The application of the bandage in simple bone-fractures,

as well as the materials employed for this purpose have already been described in a previous hand-book (Bayer, "Operationslehre"). I, myself, employ plaster-of-Paris bandages exclusively in horses and dogs, and consider other forms of bandaging material (tripolith, silicate-of-potash, gutta percha, lime, rubber, starch, dextrin, pitch, paste-splints, wooden splints, splints of iron and celluloid), as, at least, superfluous. Under certain circumstances they may be employed as an emergency bandage. The plaster-of-Paris bandage is applied as follows: after reposition is complete the broken ends of the limb are firmly fixed above and below by one or two attendants; thin layers of padding are applied, especially at the seat of fracture, so that the broken ends are well bolstered; a cambric or flannel bandage is applied over the whole. For horses the application of padding may be omitted. Over this bandage are then applied the turns of plaster bandage which have been previously prepared from fresh plaster and soaked for a short time in warm water. It must be applied in such a manner that a uniform and extensive layer of plaster comes in contact with the broken area and its vicinity. The bandage may be strengthened by applying some of the prepared plaster in the form of a paste. The following general rules must be observed when applying a plaster bandage:

1. The bandage must not exert too great pressure nor form cord-like constrictions. One should also observe that the folds of the plaster bandage are not too large or unequal.

2. The bandage should be inspected daily with special reference to pressure and constriction. In dogs the paw of the involved limb should receive special attention with reference to swelling, blue coloration, and necrosis. In these cases the bandage must be loosened, or entirely removed.

3. The bandage, on the other hand, must not be applied too loosely. The swelling which occurs the first few days after fracture disappears as a result of the resorption of the exudate; the bandage, though properly applied, becomes loosened, and must then be renewed. In

such cases a provisional bandage may be employed for the first few days, until the swelling has diminished.

4. Special care is required in the application of a padding over the seat of fracture in dogs. In the following areas there is great danger from pressure necrosis as a result of faulty padding : the skin over the olecranon and os calcis, as well as upon the bony processes of the carpus and tarsus. Necrosis is characterized by fetid odor and fever, as well as general disturbances. In such cases the bandage must be immediately removed and the contused area treated with antiseptics.

5. The retention of bandages to the extremities of dogs is maintained by passing a plaster-saddle over the back or thorax so that it passes down on the opposite side. This method prevents falling down and tearing of the bandage. The plaster-saddle is especially useful in fractures of both anterior and posterior limbs.

6. When possible, the neighboring joints above and below the fracture are included in the bandage. This favors immobility of the fractured area.

7. After the application of the bandage the animal is kept as quiet as possible until time for removal. Horses are best retained in slings or tied high, and given plenty of soft bedding ; dogs are locked up. Cagny healed many fractures in dogs by merely locking, without bandage, in a very narrow cage. The bandage may be removed from dogs after three or four weeks ; upon horses it should remain six to twelve weeks.

Application of bandages recently employed in a man by means of which the patient may move about, and thus prevent severe muscular atrophy and general derangements, are not applicable to the lower animals. Callus formation, on the other hand, may be promoted in the lower animals by the internal administration of phosphorus. In the horse the dose is one one-hundredth to five one-hundredths grams ; in the dog, one half to two milligrams. Neurectomy as a last resort may be employed where lameness remains as a result of fracture of the first, second, or third phalanx.

TREATMENT OF COMPOUND FRACTURES.—Because of the existence of an open wound, treatment is essentially different from that of a subcutaneous fracture. In contrast to the pre-antiseptic times, with the introduction of aseptic and antiseptic methods, and with the results of experience obtained during the past ten years in the surgery of war (v. Bergmann and others) the prognosis of compound fractures, which were formerly treated almost exclusively by amputation, has become far more favorable. In human surgery, from a therapeutic standpoint, one distinguishes four varieties of compound fracture:

1. When there exists only a trivial, fresh perforation of the skin by a pointed fragment of bone (penetrating fracture) a so-called aseptic, plaster-of-Paris occlusive bandage is applied. Aseptic occlusion is produced as follows: careful disinfection of the skin, reduction of the perforating fragments of the fractured bone, application of an evenly applied aseptic bandage over the fractured area, the whole is then enveloped in a plaster bandage which remains in position until healing is complete.

2. Plaster-of-Paris bandages cannot be applied in the following cases: recent compound fractures with extensive injury to the skin or soft parts, especially with splintering, or fractures which produce an open joint. Such fractures are treated as follows: carefully disinfect according to the rules of antisepsis; remove all lacerated tissue, blood clots, bone-splinters, and foreign bodies, very sharp fragments may be removed with the forceps; ligate bleeding vessels; enlarge the skin-wounds until the broken ends are freely visible; carefully irrigate the cavity of the wound, provide drainage, and insert a tampon of iodoform gauze; in certain cases the skin may be partially sutured, an aseptic bandage is then applied, this is changed according to the demands of each case. A plaster bandage should be applied only after complete healing of the

wound. A plaster bandage with a window is applicable only to small injuries; through the window in the cast the wound is treated with aseptic bandages.

3. Old—more than one or two days—suppurating, complicated fractures, especially those in which there exists an ichorous wound secretion, gangrenous decomposition of the tissues, as well as septic phlegmon in the vicinity of the fracture, must be treated with energetic disinfection. When necessary open incisions may be made, they are best treated with permanent antiseptic irrigation.

4. With extensive crushing and bruising of the entire fractured area, as well as with imminent septic general infection from an extensive, suppurating and ichorous fractured wound, when local treatment cannot be employed because of danger to the life of the patient, amputation of the entire limb remains as a last resort. In general, amputation is indicated in both the above named conditions. In veterinary practice its use is restricted to dogs.

Fixation of the fragments with ivory nails or by means of bone-sutures, employed largely in human surgery, are also applicable to small animals, as well as to fractures of the inferior maxilla in the horse.

PROPHYLAXIS OF BONE FRACTURES.—In horses, prevention of fractures while casting forms an important surgical problem. Fractures of the vertebral column, femur, or pelvis may occur. While the pathogenesis of these individual fractures is treated in text-books of special surgery, the following remarks concerning their prevention find place here:

1. Fractures of the vertebrae occur most often while casting old horses and thoroughbreds. In old horses the causes are due to a senile atrophy of the bone, a rarefying ostitis, or an anchylosis of the vertebral joints. While palliative methods are not applicable, one should observe the following principles: when possible, operate old horses standing (tooth operations), cast the animal only when absolutely necessary. In thoroughbred animals casting for castration, especially, affords an opportunity for the existence of spontaneous fractures as a result of excessive contraction of the longissimus dorsi and ileo psoas, thereby producing excessive flexion of the vertebral column. Prophylaxis consists in a previous weakening

of the animal: light diet, exhaustion by high-tieing and over-exercise, administration of laxatives (arecalin, eserine), subcutaneous injections of morphine, clysters of chloral hydrate (75-150 grams); further, the application of a dorsal girth previous to casting, with the greatest possible extension of the neck and head while in the recumbent position; in prevention of lateral movements by the application of a crupper and fixation of the head, in the application of a twitch or the use of chloroform.

2. Fracture of the femur is favored by struggling in the hopples, firm fixation of the upper limb in an abdominal girth, as well as permitting the limb to pass too far forward. Struggling against fetlock straps is prevented by a twitch on the limb. When tieing the hind limb it should be excessively flexed (Danish method), or allowed a certain amount of mobility (Berlin method). Care should be taken that the foot is never carried forward and outward over the elbow-joint. Further, one applies a nasal twitch, or chloroforms nervous horses.

3. Pelvic fractures are caused by throwing on hard ground. They are easily prevented by providing a thick layer of straw.

From a forensic standpoint the facts mentioned are of great importance. If an operator is able to maintain that previous to casting and during the operation, the above named prophylactic methods were accurately and thoroughly carried out, that he employed suitable casting-apparatus, and gave accurate instruction to the attendants, he is in no way responsible if fractures do occur. Such fractures occur regardless of the most careful prophylaxis, and without any fault or responsibility on the part of the operator. My experience has demonstrated that special precautions by means of a girth along the back, Bernadot and Butel's apparatus do not always prevent fracture of the vertebræ. I must, therefore, contrary to the statements of others, coincide with Möller's opinion that casting horses is always associated with a certain amount of danger.

II. INFLAMMATION OF BONE, PERIOSTITIS, OSTITIS, OSTEOMYELITIS.

CLASSIFICATION.—Inflammation of bones, as well as inflammation of other organs, may be classified from various standpoints. The following forms are differentiated: according to the course, acute and chronic; according to the cause, traumatic, spontaneous, hematogenous,

and specific (tubercular, actinomycotic, botryomycotic, pyemic, glandular), primary and secondary (symptomatic, metastatic); bacterial (septic), and non-bacterial (aseptic); finally, according to the character of the inflammatory product—suppurative, ossifying, fibrous, granular, and necrotic inflammation of the bone. From a standpoint of practical surgery they are classified from an anatomo-physiological standpoint with reference to inflammation of the periosteum, genuine bone-substance, and bone-marrow. While in man, hematogenous infection and inflammation of the bone-marrow is by far the most important form of inflammation of the bone, in veterinary science this is not true. In animals, inflammation of the periosteum holds the most important position. This is especially true of horses where the periosteum, as an external covering of the bone, is exposed to many traumatic insults.

In text-books of veterinary surgery osseous inflammations are arranged as follows in the order of their importance:

1. Inflammation of the periosteum (periostitis).

2. Inflammation of the bone-substance (ostitis).

3. Inflammation of the bone-marrow (osteomyelitis).

1. INFLAMMATION OF THE PERIOSTEUM, PERIOSTITIS.

FORMS.—According to the causes, course, and inflammatory products, and above all, with reference to the treatment, the following forms of periostitis are recognized:

a) Acute non-suppurative periostitis, which is also termed aseptic, traumatic inflammation of bone. It is not due to the action of bacteria, but to mere traumatic irritants (contusions, pressure, blows) acting subcutaneously. An acute, aseptic periostitis develops, for example, as the immediate result of a subcutaneous bone-fracture. The ordinary causes in horses are kicks, blows, treads on the

coronet, pressure on the interdental space, and collisions; the inflammation, therefore, is usually circumscribed. As the periosteum is a membrane having a very rich nerve-supply, recent cases of inflammation are characterized by extreme pain on palpation, lameness, a circumscribed semi-soft swelling, and heat. Treatment consists in the application of moist warmth, Priessnitz bandages, massage, application of camphor, iodoform, and iodine ointment or grey mercurial ointment. Ordinarily the acute form passes into the following form; into a chronic ossifying periostitis.

b) Chronic ossifying periostitis develops from the preceding. It is located in the deeper layer of the periosteum, through the ossifying activity of this layer the inflammatory product is transformed to bone. Callus formation in simple bone fracture is a typical example of ossifying periostitis (see page 206). In the same way there develop from the circumscribed, acute, non-suppurative periostitis, chronic inflammatory new formations of bone which are termed osseous proliferations or exostoses (osteophytes, hyperostoses, supraossa). In the horse this is the most important form of inflammation of the bone, and one of the most frequent of bone diseases. It is especially frequent on the inner surface of the metacarpus, in the region of the coronary-joint (ringbone, pseudo-ringbone; the exostoses correspond to the attachments of capsular and lateral ligaments), in the region of the tarsal-joint (spavin, lateral exostoses), as well as on the inferior maxilla (pressure on the interdental space; pressure from the manger on the inferior margin). In all these cases the exostoses are due to chronic, frequently-repeated, traumatic irritation of the periosteum, as in ringbone caused by a continual unilateral strain on the ligaments due to an abnormal position of the hoof. The frequent occurrence of exostoses on the inner surface of the metacarpus is partially referable to a unilateral strain on the periosteum between the metacarpus and splint bone. Of 784 exostoses, not less than 651 (83 per cent) were on the inner surface (374 left, 277 right; Preussische Militär-Veterinär-

Berichte 1886 to 1895). According to Zschokke seventy-five per cent of all adult horses suffer from exostoses on the metacarpus, ninety-three per cent are located on the inner surface. In a similar manner Zschokke found that sixty per cent of all adult horses are affected with exostoses at the fetlock (pseudo-ringbone). One also finds exostoses on the humerus in chronic bursitis intertubercularis, in the alveoli of the teeth in chronic alveolar periostitis (adhesion between the teeth and the alveolar wall, difficult tooth-extraction), as well as on many bones in the form of so-called multiple, symmetrical exostoses and hyperostoses. A multiple exostosis formation in dogs has been described by Kitt; many of the bones, especially the inferior maxilla, the radius, and the bones of the lower limbs presented bony exostoses which clearly corresponded to muscular attachments. He considered it a multiple hyperplasia of the bones of myopathic origin, caused by muscular strain, and apparently influenced by a pathogenic predisposition. Occasionally exostosis formation leads to anchylosis—that is, osseous adhesion between two joints (spavin, ringbone, vertebral column), as well as to synostosis (bony adhesions between the metacarpus and splint bones). Treatment of ossifying periostitis consists in the application of blisters, firing, periosteotomy, and neurotomy. Many exostoses gradually diminish in size, occasionally they completely disappear.

c) Acute suppurative periostitis is usually due to an external injury (bone-wound, compound fracture) whereby pus-forming bacteria gain entrance to the periosteum. The cause of the infection rarely gains entrance through the blood-stream (metastatic), or extends from a suppurative inflammation of the bone-marrow; in the latter case there exists a so-called subperiosteal abscess. Treatment consists in incision and antiseptic irrigation.

d) Chronic suppurative periostitis develops from the preceding. It often leads to osteomyelitis, necrosis of the bone, and fistula formation. It is most frequently observed as a sequela of a complicated fracture (fistula of the rib, pelvic

fistula, sternal fistula), as a result of pressure on the interdental space, as well as in alveolar periostitis (tooth-fistula, empyema of the superior maxillary sinus). Treatment is operative (incision, curettage, trepanation, tooth-extraction).

The chronic fibrous periostitis is a chronic inflammation of the external, connective-tissue layer of the bone, which, in contrast to the deeper layer of the periosteum, contains no osteoblasts. It leads to the formation of so-called periosteal callosities with a subsequent atrophy of the bone. It occurs in the horse on the bridge of the nose as a result of pressure from the nose-band, it also results from pressure on the interdental space.

2. INFLAMMATION OF THE BONE-SUBSTANCE. OSTITIS.

FORMS.—Inflammation of the tela ossea occurs in the marrow tissue and in the vessels of the Haversian canals, as well as in the bone-substance lying directly over these areas; it may also occur in the marrow spaces of the spongy bone. The ostitis is usually chronic and is due, either to external irritants, especially pressure and contusion (spavin, articular ringbone), as well as compound fractures; or to specific inflammatory irritants (actinomycosis, glanders). It may also result from extension of inflammation from the periosteum or bone-marrow; it is seldom of hematogenous origin. The following forms are recognized:

a) Rarefying ostitis, that is, an inflammation of the bone characterized by atrophy of the bone-substance (osteoporosis) with the formation of hollow spaces (lacunæ). The atrophy of the bone is the result of a lacunar bone-resorption. The initial stages of spavin and ringbone are typical examples of rarefying ostitis in the horse, it is due to severe, continued contusion of the bones of the tarsal-joint, and the bones of the first and second phalanges as a result of overexertion of the horse. Rarefying ostitis has been recently demonstrated as a cause of idiopathic fractures of the first phalanx, second phalanx, and other bones (fragilitas ossium) of the horse (ostitis of fatigue). Actinomycosis of the interior maxilla in cattle presents a combination of rarefying ostitis and ossifying periostitis. The transformation from a provisional to a

definitive callus in fractures is characterized by a rarefying ostitis. Demarking inflammation of the bone in sequestration is a similar process. Finally, many consider osteomalacia a chronic rarefying ostitis with a consecutive decalcification of the bone.

b) Condensing ostitis is a process directly opposite to the preceding. Instead of atrophy it leads to new formations, induration, and thickening of bone (osteoschlerosis, schlerotic ostitis, eburnation). It is observed as a form of cicatrization at the termination of callus formation, in the latter stages of spavin, in the vicinity of bone-fistulæ and bone-sequesters (inferior maxilla), as well as after the administration of small amounts of phosphorus.

c) Granular or fungoid ostitis is characteristic of tuberculosis of the bones. It is of a hematogenous origin and in combination with a granular osteomyelitis leads to the formation of tuberculous granulation-tissue and to a suppurative liquefaction of the bone (caries). For details concerning tuberculosis of the bones see page 171. Many forms of arthritis and glanders of the bone lead to similar processes. Zschokke has observed a case of glandular ostitis of the sternum with chronic fistula formation and perforation of the sternum (pleuritis).

Deforming ostitis is a chronic inflammation of the bone. In men the following bones are most often diseased: long bones, the cranium, the vertebræ, and the pelvis. The disease may be painful or painless, it leads to hypertrophy, softening, and bending of the bones. Spavin in the horse may be termed a deforming ostitis.

3. INFLAMMATION OF THE BONE-MARROW. OSTEOMYELITIS.

FORMS.—One recognizes, as in periostitis, an ossifying and a suppurative osteomyelitis. The first occurs during the process of callus formation in simple fractures; the second in healing of compound fractures. In addition to these, suppurative inflammation of the bone marrow may have hematogenous origin through the entrance of pus-bacteria from the blood (pyemia, foal-lameness, chronic swine-erysipelas, leukemia, intravenous injections of streptococci, cocci of

contagious pleuropneumonia, bacteria of chicken-cholera, etc., in serum horses). Granular osteomyelitis in tuberculosis of the bones is an example of this form. One further distinguishes a non-suppurative inflammation of the bone-marrow (serosa, albumenosa, or mucinoid non-purulent osteomyelitis) with a non-supputive but sanguino-serous, muco-viscid, synovial-like exudate, which may be due to various causes. In animals one most frequently observes a suppurative inflammation of the bone-marrow after compound fractures of the long bones, as well as in connection with suppurative alveolar periostitis, it leads to the formation of bone fistulae, bone-abscesses, and necrosis of the bone.

PRIMARY OSTEOMYELITIS IN MAN.—In men, acute primary infectious osteomyelitis is the most important form of inflammation of bone. This is also termed a spontaneous diffuse osteomyelitis or bone typhus. It is found especially in young individuals and has been recently considered a pyemic osseous affection of developing bones, or as a phlegmon of the bone-marrow. Bacteriological investigations have demonstrated that it is due to no specific infectious disease, but that it may be caused by any pus-forming organism, it may be caused, therefore, by many bacteria, especially in the form of mixed infection. The infectious irritant is most often found to be the staphylococcus pyogenes aureus (staphylomycosis of the bone-marrow). In other cases one of the following has been demonstrated as the exciting cause: staphylococcus pyogenes albus and citreus, streptococcus pyogenes, micrococci, colon-bacterium, pneumococci, and even the typhus-bacilli. The infectious material named has various paths of entrance to the blood (intestines, tonsils, lungs, skin) and develops a hematogenous osteomyelitis. This is usually primary, that is, it runs an independent course; it may, however, occur as a secondary affection in connection with other infectious diseases. Frequently only one bone, the femur, is affected; at other times several bones may be involved. On post mortem

examination the following changes are found: multiple, confluent pus-foci in the bone marrow, and even total suppuration and ichorous ulceration of this tissue; there also occurs a suppurative periostitis, necrosis of the bones, bending and curvature of the bones, as well as pyemia and septicemia. Severe types of the disease present the following clinical symptoms: very high fever, pronounced local swelling and pain, as well as severe general disease which occasionally leads to death in a few days (type of typhus). In other cases the disease presents the symptoms of an acute articular rheumatism. One also observes a chronic course; it often occurs that healing results from early operative treatment (removal with a chisel, curettage, resection, amputation).

PRIMARY OSTEOMYELITIS IN ANIMALS.—Are domestic animals also affected with an acute infectious osteomyelitis? As a result of experience with pyemia, foal-lameness, swine-erysipelas, and serum-inoculations, its occurrence cannot be disputed. Osteomyelitis has been experimentally produced in growing rabbits by intravenous injections of staphylococcus pyogenes aureus (Lexer, Rodet). Spontaneous cases, however, with the exception of two in the horse described by myself and Kärnbach (Monatshefte für praktische Tierheilkunde, 1903), have not been recorded from reliable sources in veterinary literature. In both these cases staphylococci were demonstrated as the cause; the paths of entrance are through injuries in the skin, especially those resulting from gangrenous dermatitis (grease). At the same time a contusion occurred as a predisposing cause of the disease. In both horses only short, spongy bones were affected, especially the first and third phalanges.

The clinical appearance of osteomyelitis consists of the following symptoms, which are very important from a diagnostic standpoint: the first symptom of osteomyelitis in horses consists of a suddenly developing lameness in the diseased foot. From the very first this may be so pronounced that the animal

will be unable to bear weight on the limb; the degree of lameness may be very slight at first so that recovery is apparent, this being followed in a few days by a sudden and pronounced reappearance of the symptoms. If the seat of the disease is in the phalanges the animal holds the limb in an attitude of pronounced flexion. Every attempt to extend the toe results in severe pain. Pronounced swelling of the involved extremity soon follows the high-grade lameness. The swelling is relatively painless, and it is further characterized by the fact that it is present only in the vicinity of the diseased bones. After the disease has existed for a long time thickening of the bone can be easily recognized. In osteomyelitis, especially, the disease process soon involves the periosteum. The periosteal osseous new-formation is either confined to the affected area, or extends over the entire length of the bones. This thickening, which is characterized by its hard consistence, may be recognized by careful palpation combined with pressure. Finally, after more or less time, pronounced fluctuation with abscess and fistula formation appears on the surface of the swelling. Under certain circumstances incision of the abscesses, as in man, leads to a confirmation of the diagnosis, when the discharged pus contains free drops of fat, when a probe comes in contact with rough bone, or when a canal passes into the bone. The diagnosis in the incipient stages of the disease offers the greatest difficulities if no characteristic indications are present. In this case, the differential diagnosis of several diseases comes into consideration, they are easily confused, this is especially true of the following: inflammations of joints, periostites, fissures and fractures, phlegmons, botryomycosis, etc.

The prognosis of osteomyelitis in the horse is as unfavorable as in man. If the osteomyelitis, itself, terminates, the termination of the affection is relatively favorable through encapsulation of the focus of disease. Such an abscess of the bone, however, as experience has taught in man, may be a constant source of further pain and lameness.

As a result of concussions the process may become acute and again assume the form of osteomyelitis. Outward penetration of the pus is another termination. It first forms a subperiosteal phlegmon, after the periosteum has been broken down by the pus there is formed a phlegmon of the subcutem and muscles that surround the bone, this eventually results in the formation of multiple fistulæ. When the abscess is situated in the vicinity of articular surfaces (as occurred in the horses described), which is the rule in man (embolic infarcts of the epiphyseal vessels of the articular ends according to Lexer), the contents may break into the joint-cavity and lead to suppurative inflammation of the joint. The prognosis of such a secondary suppurative arthritis is always bad in horses. Finally, pressure laminitis may occur in the normal foot, general pyemia may also develop. With reference to the treatment of osteomyelitis it should be remarked that from an economic standpoint the animal should be slaughtered as soon as the diagnosis is confirmed. Operative opening of the diseased bone with the hammer and chisel followed by curettage of the pus-foci should be experimentally employed only in very valuable horses.

One case described by Haas as "Infectious Osteomyelitis in Cattle" may possibly have been a genuine case of primary infectious osteomyelitis as recognized in human surgery. A Swiss cow, from a fine milk-type, which had not been sick for the past three years suddenly became ill, presenting the following symptoms: rise of temperature (40.1 C); a hot, painful, hard swelling on the right fore-arm beneath the elbow-joint on which no injury to the skin was visible. At first the case was diagnosed as phlegmon. After ten days of fruitless treatment, during which the swelling gradually enlarged, the diagnosis of phlegmon was discarded for that of periostitis. A few days later a softening was detected in the depths of the swelling, this was incised and a small amount of pus escaped through the opening; a fistulous canal leading towards the radius was discovered. Improvement was rapid for a time, when the condition suddenly became worse, the temperature was high and the animal fell off rapidly in condition. There occurred burrowing of pus, thickening of the periosteum, the surface of the bone became rough, and small sloughed pieces of bone were found in the pus. A few days later there appeared a fluctuating swelling as broad as two hands at the left hip-joint, this was soon followed by a second (pyemic metastasis). As healing was now impossible the cow was killed. On

post mortem the following changes were noted: the bone-marrow was very red and contained suppurative foci as large as the head of a pin. The tela ossea, also, was affected with suppuration and necrosis, the periosteum was swollen and loosened as the result of a serous exudate, it could be easily raised. The pus of the bone-marrow contained staphylococcus pyogenes aureus and albus.

Lucet has described an acute, infectious osteoarthritis in young geese; staphylococcus pyogenes aureus was found in the pus. Suppuration of bone was produced experimentally in animals by injecting cultures of the coccus.

The cases described by Frank, Osterman, Janson, Schick, and others under this heading remain open to question. A classification of the pathological changes in the bone-marrow in different diseases of the horse has been arranged by Sticker.

III. NECROSIS, ATROPHY, AND HYPERTROPHY OF BONES.

1. NECROSIS OF BONES.

CAUSES.—Necrosis, that is, gangrenous death of particles of bone or entire bone, is usually the result of disturbed circulation in the bones (anemic necrosis). Necrosis may be due to traumatic influences, in which circumscribed portions of the bone are splintered by wounds or complicated fractures and thus cut off from nourishment; if wound infection occurs at the same time the splinters become necrotic, while small aseptic pieces of bone are resorbed. One frequently observes this form of bone necrosis in horses on the inferior and superior maxillæ (bone fistula), sternum (sternal fistula), on the ribs (costal fistula), and on the pelvis (pelvic fistula). In other cases the necrosis is of inflammatory origin; especially as a result of suppurative periostitis and osteomyelitis, or it may develop in the vicinity of strangles abscesses, as well as by extension of a neighboring inflammation to the bone-marrow (pus-bacteria, necrosis bacillus). In this manner necrosis of the turbinated and ethmoid bones may result from chronic inflammation of the nasal mucous membranes; necrotic pododermatitis may lead to necrosis of the os pedis; necrosis

of the tendon, to necrosis of the navicular bone ; phlegmon of the neck, withers, or tail, to necrosis of the cervical vertebræ, the dorsal spines, or the coccygeal vertebræ. Necrosis of the cartilage occurs in a similar manner (fistula of the lateral cartilage.) Bone-caries is a special form of necrosis of the bones. It is usually the result of a granular, tubercular ostitis and osteomyelitis, which leads to the death of portions of the bone, and to lacunar liquefaction and progressive softening, with partial resorption of the necrotic portions (Cf: Tuberculosis of the Bones, page 171). When pieces of bone are sloughed off during the course of caries it is termed necrotic caries. A similar form of caries affects the teeth, especially the molar teeth of horses, so-called tooth-caries. This consists in a progressive degeneration of the cement and the dentine-substance caused by the decomposition of masses of food, and the entrance of bacteria through spaces in the enamel (rasping!) into the substance of the tooth. Embolic necrosis is very rare in the domestic animals (primary embolic necrosis of the first and third phalanges, see page 223 ; embolic necrosis of the sphenoid bone in contagious pleuro-pneumonia). Phosphorus necrosis of the maxillary bones as seen in man, has been observed only in experimental animals (rabbits) after the inhalation of fumes from phosphorus.

FORMS.—One recognizes a partial (circumscribed) and total (diffuse), a simple and multiple, as well as a superficial and deep necrosis.

The latter classification is of special practical importance.

a) Deep necrosis is usually circumscribed. The necrosed piece of bone is termed a sequester, the process of sloughing is termed sequestration. The sequester is separated from the sound bone by a demarking ostitis, its surface becomes corroded and liquefied as a result of lacunar bone resorption (osteoporosis, erosion) at the same time there develops a wall of newly-formed osseous tissue around the line of demarcation in the form of a bone-capsule (bony case, dead covering). From the bony covering a canal frequently leads to the surface (bone-fistula), the sequester frequently passes through

the canal and is cast off. Occasionally the entire bone is thickened during the process of sequestration. Total necrosis of a large bone is very rare—for example, the scapula of a horse (necrosis formation extending from the periosteum).

b) Superficial bone-necrosis is frequently characterized by exfoliation.

TREATMENT.—As in treatment of other organs, treatment of bone-necrosis is purely operative. It consists in removal of the necrotic portion—the bone-sequester, which sustains the bone fistula, by means of curettage, the bone-chisel, and trephine, and the removal of the sequester with bone-forceps (sequestrotomy, necrotomy). The injection of caustics, as well as cauterization of the fistulous tract, seldom results in healing.

2. ATROPHY OF BONE.

FORMS.—One recognizes a concentric atrophy, that is, one extending from without inwards, which is also termed erosion atrophy of the bone; and an excentric, one which proceeds from within outwards (osteoporosis). A classification according to causes is more important. According to the latter classification the following forms are recognized:

a) Inflammatory atrophy or osteoporosis occurs during the course of a rarefying ostitis (initial stages of spavin, actinomycosis, osteomalacia, leukemia).

b) Pressure atrophy or erosion occurs on the os pedis through pressure from the horny sole; on the navicular bone during podotrochlitis; on the vertebral column as the result of an aortal aneurysm; on the nasal bones through tumors within or external to the nasal cavities; on the maxillary and frontal bones through new-formations in the maxillary and frontal sinuses; cœnurus cerebralis may cause atrophy of the bones of the skull.

c) Atrophy of inactivity occurs with muscular atrophy in chronic forms of lameness (spavin, ringbone), especially on the tarsus, metatarsus, and metacarpus.

d) Senile atrophy may lead to fracture of the vertebræ during the act of casting old animals.

e) Neurotic atrophy during the course of diseases of the nerves (neuroparalysis), and subsequent to incisions of the nerves.

3. HYPERTROPHY OF BONE.

FORMS.—One recognizes a circumscribed (exostoses, osteophytes), and a diffuse hypertrophy of the bones (hyperostosis). There is also a form of hypertrophy that occurs within the bone itself, this is termed osteoschlerosis or eburnation. All these three forms are of inflammatory origin. In contrast to these there has been observed a congenital hypertrophy of bone, which is especially seen in horses and dogs on the bones of the skull and face (leontiasis ossea, big-head). Congenital hypertrophy of different extremities, the toes for example, is termed macrodactylia; congenital hypertrophy of bone, with a simultaneous hypertrophy of the soft parts, is termed acromegalia; acromicria is an opposite condition.

APPENDAGE. RACHITIS AND OSTEOMALACIA.

DEFINITION.—The nature of rachitis and osteomalacia as well as the relation of both to each other has not yet been determined in a manner entirely satisfactory and consistent. Ordinarily rachitis is defined as a bone-disease which affects young, still developing bones; as a result of the disease they do not ossify, but continue in a form of cartilaginous development. In contrast to this, osteomalacia or bone-fragility, is a disease of old, developed bones which is characterized by the loss of bone salts (halisteresis). The following are classified among the causes of both diseases: specific infectious inflammations of bone (epizootic development, inflammation of bone similar to that caused by phosphorus poisoning); deficiency of lime in the food (experimental development of rachitis in young animals as a result of living on food deficient in lime salts, rachitis in pigs and dogs kept on an exclusive diet of potatoes and bread, osteomalacia in anemic milch cows whose diet is poor in lime). For further information see Friedberger and Fröhner: "Special Pathology and Therapeutics." 1904, Sixth Ed. Vol. I.

RACHITIS.—Rachitis (softening of the bone) most frequently occurs in young pigs and puppies, as well as in birds. It is seldom seen in foals and calves. According to Kassowitz rachitis is characterized anatomically by a pathological vascularization of the bone-forming tissue in the form of a chronic hyperemia and inflammation at the seat of apposition (epiphyses, periosteum, and bone marrow). This results in the following changes:

1. Proliferation of the cartilage at the epiphyses.
2. Lacunar liquefaction (halisteresis) of the formed bone.
3. Irregular deposits of lime in the developing bone.

In general the anatomical changes in the bone are as follows: the periosteum is hyperemic and presents, on the inner side, a pronounced proliferation and thickening of the bone-forming layers, whereby the newly developed tissue is not ossified, but, for the most part, remains soft. Ossification of this tissue occurs later, this gives the bone a thick, plump appearance, a circumscribed enlargement is recognized. The periosteal proliferations are most often seen at the muscular attachments; in swine at the femoral attachment of the psoas magnus and internal iliacus, very often at the tuberosity of the calcaneum; in certain cases the thickened periosteum may be torn away from bones by muscular contraction, in swine from the scapula. The principal changes in rachitic bones occur at the boundaries of the epiphyses and consist in an abnormal proliferation of the epiphyseal cartilage without sufficient calcification. Normally the cartilage between the epiphyses and diaphyses is composed of two, thin, parallel layers; the proliferating and the ossifying layer. In rachitic bones the proliferating layer is overdeveloped, while the ossifying layer is abnormally small; instead of being parallel they are now irregular. This abnormal proliferation of the epiphyseal cartilage leads to a thickening and swelling of the epiphysis which ossifies only when the disease has run a long course; it leads to a curving and bending of the long bones, and finally to a dislocation of the epiphyses whereby the attachment between the epiphyses and diapyses becomes loosened.

The most important symptoms of rachitis consist in a swelling and enlargement of the epiphyses of the bones in the vicinity of the joints (double-jointed); in a bending and curvature of the bones of the extremities (shaped like the limbs of a badger hound, or like a sabre); the vertebral column is curved downwards (lordosis), upwards (kyphosis), or laterally (scoliosis). Swellings occur at the articulations of the ribs and costal cartilages (rachitic beads); the pelvis becomes deformed (rachitic pelvis); the coronary joint presents exostosis formation (rachitic ringbone); asymmetry occurs in the formation of the skull; formation of a so-called chicken-breast, etc.

Treatment of rachitis consists, in addition to the removal of the cause (change of food), in the administration of phosphorus; for the horse, one to five centigrams; dog, one half to two milligrams. They should receive a diet of bone-meal.

OSTEOMALACIA.—Osteomalacia, or bone-fragility, is most often seen in milch cows, especially during the period of lactation or pregnancy; it is occasionally seen in horses (bran-disease, osteoporosis). Opinions concerning the nature of the disease are extremely variable.

1. Virchow and others consider it a chronic, parenchymatous inflammation of the bone or a rachitis of adults. As a result of accelerated vascular proliferations there results, on the one side, a new-formation of soft, osteoid masses; on the other, a lacunar resorption (halisteresis).

2. Ziegler considers it a pure halisteresis—that is, a simple decalcification of the bones without inflammatory new-formation.

3. Peptrone has defined bone-fragility as an infectious disease due to a specific bacterium (nitrification).

The anatomical changes in the bones, which are especially prominent in those of the trunk and upper limbs, are as follows: in the early stages of the disease and in light attacks, if one examines carefully, an increased blood-supply is visible in the diseased bones. There is a dilitation of the vessels and the canals through which they pass. A section of the bone brings into sight small hemorrhagic points, the marrow is infiltrated with many small extravasates, the bone tissue in the vicinity of the dilated Haversian canals presents slight changes. In a more severe type the hyperemia is pronounced; the external surface of the matrix, as well as a cut surface of the bone, present highly colored points, the marrow is very hyperemic and filled with hemorrhagic areas. The marrow cavities are dilated. In the diploe and on the inner surface of the matrix one finds many small pieces of bone that have become loosened from the surrounding tissue. The bones are easier to saw or cut, their tone is not so clear. Microscopically the homogeneous structure of the bone substance is atrophied; in certain areas it appears more transparent, the bone-corpuscles are enlarged and transparent, in form they become oval, round, and even polyhedral, their processes disappear. The bone-cells gradually undergo fatty degeneration. The entire process is a transformation of certain areas of the bone-substance into osteoid, and finally into marrow tissue. In the most severe types of osteomalacia the hyperemia of the bone and marrow is still more pronounced, the osseous substance becomes spongy, more friable, and softer; the matrix and diploe become smaller and smaller; the marrow gradually increases. The matrix is displaced from within

outwards, and is removed, even at the epiphyses; fractures of the bone occur. When there exists a general derangement of the nutrition, the marrow itself becomes softened, gelatinous, even watery, and presents a dirty-yellow color. The specific gravity of the bone diminishes until more than half of the lime salts have disappeared; it contains, however, more water.

The symptoms of osteomalacia in cattle are as follows: severe derangement of the nourishment, emaciation, weak digestion, symptoms of opsomania, hardening of the skin, cachexia, lameness, bone-fractures, infractions, and distorsions. Fractures of the pelvis and ribs are especially frequent, they often result from the slightest provocation (rising, lying, twisting, parturition), and are often multiple.

Treatment consists in a change of food (food containing lime), administration of bone-meal or phosphates of lime, as well as, above all, in the internal administration of phosphorus (1-5 centigrams per cow) in oil. Ovariotomy (castration) has been followed by good results in man, it may be experimentally employed in cattle.

DISEASES OF JOINTS.

ANATOMICAL CONSIDERATIONS.—From a surgical standpoint the synovial structures (joint-capsule, synovial membrane) are the most important anatomical portions of the joint. In comparison with the capsular ligament, the other ligaments of the joint, especially the lateral ligaments, anterior and posterior ligaments, etc., are of secondary importance from a surgical standpoint. By most authors the synovial membrane is considered a serous structure which has its analogue in the peritoneum and the pleura. Its inner surface is covered with a simple endothelial layer which covers the processes—the diverticuli and villi of the synovial membrane—but does not cover the cartilage. Only in the fetus, as well as after a long period of rest for the joint, does the synovial endothelium partially cover the cartilage. The external layer of the synovial membrane, which serves as its basis, is composed of a net-work of connective-tissue and elastic fibers. (Others consider the synovialis, not a serous, but a fibrous membrane).

The villi of the joint form fine, hair-like proliferations directed from the synovial membrane towards the cavity of the joint, occasionally daughter-villi are present. According to their histological characteristics they are classified as follows: mucous villi, fat-villi, cartilaginous villi, and fibrous villi, between these there frequently occur transitional forms. According to Tillmanns the synovia is formed principally from the mucous and fat-villi, partly through secretions, partly through a solution of their cellular

elements. Schneidemühl, on the other hand, supports the theory that Tillmanns' classification depends on a pathological condition, and that the synovia is not formed by a continual disintegration of the endothelial cells, but, as in other serous cavities from an independent secretion. The secretory activity forms, therefore, the principal function of the endothelium of the joint. The villi of the synovial membrane and joint are extremely rich in vessels especially in lymph-vessels, which apparently communicate directly with the joint-cavity through open stomata; this explains the great resorptive ability of the joint-capsule. The hyaline cartilage, which covers both ends of the bones, is only apparently homogeneous, normally it is composed of small fibers, this explains the fibrillation found in various pathological conditions (Tillmanns).

I. INFLAMMATION OF JOINTS. ARTHRITIS OR SYNOVITIS.

CLASSIFICATION.—According to the causes, anatomical characteristics, and course, inflammation of the joints (synovitis) may receive various classifications.

From an etiological standpoint, one distinguishes, above all, a non-infectious (aseptic), and infectious (septic) inflammation of the joint. Traumatic arthritis is the most common, that is, an arthritis due to injury, it may be aseptic or septic. There is also recognized a primary and secondary inflammation of joints. The primary develops direct, at the seat of action of the inflammatory irritant. The secondary develops through extension from a neighboring inflammatory process; for example, inflammation of the joint extending from the bone, or hematogenous through the medium of the blood. Hematogenous arthritis has been termed symptomatic or metastatic. It occurs during the course of infectious diseases (acute articular rheumatism, pyemia, septicemia, contagious pleuropneumonia, infectious abortion, foal-lameness, petechial fever, malignant head-catarrh in cattle, strangles, swine-erysipelas, swine-plague, dog-distemper, glanders, tuberculosis, intravenous injections of streptococci, etc., and in serum horses), it is occasionally seen in cattle as the result of abortion, retention of the fetal membranes, and metritis (puerperal pyemia), as well as in lameness in calves (polyarthritis); in goats during

the course of an infectious agalactia; finally, as the result of certain constitutional diseases (gout). When several joints are diseased at the same time it is termed polyarthritis (rheumatic, septic, uric, pyemic), in contrast to traumatic monarthritis. Symptomatic inflammations of the joints include the specific forms of arthritis (tuberculosis, glanders, actinomycosis).—In cattle, even certain physiological forms of arthritis are observed, those occurring with change of teeth and development of bone "dentition arthritis" (?). According to the course, arthritis is classified as acute and chronic.

According to the anatomical character of the inflammation, one distinguishes an exudative and a dry inflammation of the joint (arthritis sicca). According to the character of the exudate and the product of the inflammation one further distinguishes the following forms: serous, serofibrinous, fibrinous, suppurative, hemorrhagic, ichorous, deforming, caseous, catarrhal, pannous, fungoid, granular, erosive, and ulcerative arthritis.

In the domestic animals the following are the most important and most frequent forms of arthritis, because of their practical importance they are fully described:

1. Serous arthritis.
2. Suppurative arthritis.
3. Deforming arthritis.
4. Tubercular arthritis.

1. SEROUS INFLAMMATION OF JOINTS. ARTHRITIS SEROSA.

CAUSES.—Serous arthritis is most frequently observed in dogs and horses as a traumatic, aseptic inflammation resulting from contusions and distorsions. It may occur, however, as a symptomatic arthritis, especially in acute articular rheumatism (polyarthritis serosa), less frequently in pleuropneumonia, as well as metastatically in cattle as a result of retention of the afterbirth; it may also occur during the course of mastitis (hip-joint, knee-joint, tarsal-joint).

SYMPTOMS.—Serous inflammation of the joints occurs in two forms: acute and chronic.

a) Acute, serous arthritis is usually a traumatic inflammation of the tarsal-joint, fetlock-joint, knee-joint, carpal-joint, or hip-joint, without injury to the joint-capsule. It develops suddenly and presents the following symptoms: a circumscribed and fluctuating swelling, intense pain, lameness, and increased temperature of the involved joint, there is not usually a general rise of temperature. High fever is present only in symptomatic arthritis. Acute serous arthritis terminates in resorption of the fluid exudate followed by healing, or, if resorption fails, it passes into the chronic form. In the latter case the prognosis is unfavorable.

b) Chronic serous arthritis, also termed chronic hydrops or joint-gall, develops from the acute form, or it may be progressively chronic in nature. In the latter case it is often supported by a hereditary predisposition in the form of an atony or slight vulnerability of the joint. In contrast to acute arthritis, the swelling of a chronic hydrops is painless and retains a normal temperature; interference with movement is absent or slight. Occasionally this form is intermittent in character. It is especially common in horses and cattle in the form of so-called galls or the fetlock-, tarsal-, or knee-joints.

TREATMENT.—Acute serous arthritis in the early stages is treated as follows: rest, moist heat, Priesnitz compress, compression, plaster-of-Paris bandage, and massage; in the latter stages, with irritating applications (tincture of iodine, cantharides-collodion). The often incurable, chronic serous arthritis may be treated with blisters and firing. The method of treatment successfully employed in human surgery, where the joint is punctured in an aseptic manner and followed by antiseptic irrigation, is not indicated in the treatment of the horse where a bandage can be applied only with difficulty or not at all. In the treatment of dogs this method may be experimentally employed. From a prophylactic standpoint horses with joint-galls may be excluded for breeding purposes.

2. SUPPURATIVE INFLAMMATION OF JOINTS, ARTHRITIS PURULENTA.

CAUSES.—Suppurative or pyo-ichorous arthritis is due to the entrance of pus-forming bacteria into the joint. As a rule they gain entrance through perforating joint-wounds. In other cases a suppurative inflammation in the vicinity extends to the joint (subcoronary phlegmon, suppurative podotrochlitis and pododermatitis, phlegmon of the fatty frog to the pedal-joint). Pus-bacteria may also gain entrance to the joint through a hematogenic course; this is the most often seen during the course of a pyemic polyarthritis in foals and calves. In horses, the severe, acute suppurative arthritis which usually terminates in septicemia is most often caused by staphylococcus pyogenes aureus; the subacute type, by streptococcus pyogenes (Bosi). Staphylococcus pyogenes aureus (Sohnle) and streptococcus pyogenes (Ostertag) have also been found in suppurative and sero-purulent polyarthritis of foal-lameness. In polyarthritis of calves, on the other hand, the colon bacillus seems to play the principal part (Zschokke).

PATHOLOGICAL CONDITION.—In a suppurative and ichorous arthritis one finds greyish-yellow or light-yellow, cream-like, and viscid contents in the joint (suppurative arthritis); or an ichorous, discolored, brownish, chocolate-colored, greyish-brown, or dirty-green fluid, which is fetid and filled with bubbles of gas (ichorous arthritis). The synovial membrane is swollen, highly reddened, markedly thickened (as much as one-half centimeter), and similar to an abscess-wall; the inner surface is covered with villiform, soft, reddish-grey granulations. The slightest changes appear to be in the articular cartilage. Marked erosions and ulcerous defects are usually absent; occasionally the cartilage is somewhat rough and cloudy (glistening is absent), in many places it is more or less thinned and softened. Abnormal color is the most pronounced characteristic (light-grey, greyish-blue, greyish-green, bluish-white). In the ends of the bones,

when the process has existed for a long time, one finds osteomyelitic processes, inflammmatory osteoporosis and necrosis.

The general anatomical changes are usually of a septicemic nature (inflammatory swelling of the liver, spleen, pancreas, heart, gastric glands, edema of the lungs and glottis, hemorrhagic laryngitis and pharyngitis). Pyemic changes are less frequent; this is also true of genuine metastases, especially in the lungs in the form of a multiple, focus-like gangrenous pneumonia (necrosis bacillus).

SYMPTOMS.—Suppurative arthritis (empyema of the joint), in contrast to serous inflammations of the joint, is characterized by fever, symptoms of severe general disturbance and severe lameness, as well as a circumscribed, diffuse, circular, hot and painful swelling of the joint (parasynovial phlegmon and suppuration), occasionally periarticular abscesses are present. If this condition is accompanied by a penetrating joint-wound a suppurative discharge flows from the joint into which one may pass a finger or probe. In the horse the suppurative and pyo-ichorous forms of arthrites of the large joints, seem, as a rule, to run a rapidly fatal course as the result of septicemia or septicopyemia. In suppurative inflammation of the small joints, especially the hoof-joint, the fatal termination is somewhat delayed (one or two weeks). Suppurative inflammation of the small joints in the horse is occasionally followed by healing and anchylosis formation. This is especially true of the lower rows of the tarsal-joints (intertarsal joints, tarso-metatarsal joints) when the point cautery has been used for the treatment of spavin, of the lower rows of the carpal-joints, of the fetlock-joint, and the pedal-joint. It is a peculiar fact that the ass and mule, in comparison with the horse, are less severely affected with suppurative arthritis (Bosi). One occasionally observes a chronic form in cattle, this is especially true of the hip-joint.

TREATMENT.—The following forms are usually incurable in the horse: purulent and pyo-ichorous arthritis of

the hip-, knee-, tarsal-, shoulder-, elbow-, coronary-, and pedal-joints. In all these cases, therefore, from an economic standpoint, it is usually best to advise early slaughter. Occasionally they can be treated, as in human surgery, with puncture and incision, antiseptic cleansing, drainage, and permanent irrigation of the suppurating joint. I have observed healing in the horse in four cases of suppurative arthritis of the fetlock-joint, as well as in many cases of suppurative arthritis of the pedal-joint (perforating nail punctures, resection of the perforans tendon). Lutz has also described a case of healing. Treatment for the dog, on the other hand, is more often indicated as bandaging is more easily employed; in certain cases, one may resort to resection of the joint and amputation. In two cases I have resected a suppurative maxillary-joint in the horse with good results.

3. DEFORMING INLAMMATION OF JOINTS. ARTHRITIS DEFORMANS.

DEFINITION.—In human medicine "deforming" inflammation of the joint indicates a chronic, aseptic, senile arthritis (malum senile), which leads to permanent and severe changes in the entire joint; it is not combined with suppuration. Its occurrence may be spontaneous or traumatic; it may be either mono- or polyarticular; its favorite seat is in the hip-, knee-, shoulder-, and elbow-joints, and in the fingers and vertebral column; ordinarily it continues during life, is non-febrile, is ushered in with stiffness, crepitation, and slight sensitiveness in the involved joints; finally, it leads to deformity of the entire joint. Anatomically it is characterized by degenerative as well as newly formed processes in the cartilage, bones, and joint-capsule.

a) In the articular cartilage one finds, on the one side, changes which are typical of a chronic, ulcerative, dry arthritis; namely, fibrillation of the superficial layers, foci of disruption and softening in the deeper lay-

ers, erosion and even complete atrophy of the cartilage with the formation of smooth, polished surfaces; on the other side, there occur active proliferations of the cartilage in the form of nodular swellings.

b) In the bones there exists a subchondral inflammatory osteoporosis with lacunar atrophy of the bone, in addition to bony new-formations.

c) The joint-capsule shows proliferation, thickening, and shriveling, one also occasionally observes the formation of free joint-bodies.

These combined changes result in pronounced deformities in the involved joints, whereby their mobility is either restricted or entirely suspended, or it may result in an excessive mobility of the joints (luxations, loose joints).

OCCURRENCE IN ANIMALS.—The following diseases may be classified under chronic deforming inflammation of the joint: spavin and articular ringbone in the horse; certain forms of gonitis that are characterized by severe swelling of the joint; omarthritis (inflammation of the shoulder-joint); and coxitis (inflammation of the hip-joint) in dogs, horses, and cattle. Chronic, deforming inflammatory processes are also frequent in the pedal-joint (so-called ringbone of the pedal-joint), and in the carpal-joint (so called spavin of the carpus) of the horse. So-called chronic lameness of the pedal-joint (bursitis podotrochlearis) and sesamoid lameness in the horse, show a certain analogy to arthritis. One also observes deforming arthritic changes in chronic articular rheumatism. Sticker described a case of polyarthritis deformans in the horse which showed cauliflower-like, cartilaginous and osseous growths around the margins of the joints, thickening and villous proliferations on the synovial membrane, as well as an increase in the amount of synovia.

The relation of spavin and ringbone, as well as chronic gonitis and omarthritis in the horse, to deforming arthritis, is of special importance.

1. In the text-books on surgery SPAVIN is usually defined as a chronic deforming arthritis tarsi. In this

form the term is not entirely correct. According to the excellent investigations of Gotti, whose accuracy has been proved by Bayer, Eberlein, and myself, spavin, in many cases, is not a primary disease of the cartilage; the bone forms the primary seat of the disease. Spavin is primarily an ostitis of the cuneiform magnum and medium, as well as the metatarsus; deforming inflammation of the tarsal-joint is a secondary disease which develops from the ostitis. "Osteoarthritis chronica deformans", therefore, is a more accurate term for spavin. According to Gotti spavin is a slowly developing inflammatory process in the bones, it is characterized by decalcification (inflammatory osteoporosis, rarefying ostitis) whereby numerous small or large spaces become visible in the bone; in these spaces one finds soft, reddish masses which resemble granulation-tissue. This rarefying ostitis may be replaced by a condensing ostitis (osteoschlerosis). In many cases, especially in the initial stages, these pathological changes in the bone (rarefying and condensing ostitis) are the only ones present in spavin, the cartilage and periosteum are intact. Later in the course the ostitis may either extend in a central direction towards the joint, involving the articular cartilage; or it may take a peripheral direction, that is, extend to the periosteum (both processes frequently occur at the same time). In the first case there exists a secondary disease of the articular cartilage with degeneration of the cartilage, active proliferation of the cartilaginous cells, and the formation of an inner anchylosis. If the inflammatory process extends from the bone-substance to the periosteum it leads to an ossifying periostitis with the formation of osteophytes and an external anchylosis. The bones of the tarsal-joint have then become partly osteoporotic, partly schlerotic masses of osseous tissue. It is very rare that the inflammation extends to the bursa of the tibialis anticus (compare with Eberlein, "Der Spat der Pferde." Monatshefte für praktische Tierheilkunde. 1898).

2. RINGBONE is a collective term for various chronic, aseptic inflammatory processes at the coronary-joint. One must differentiate, above all, between articular and periarticular ringbone. In periarticular ringbone the joint itself is not involved, it consists of a periarthritis, that is, a chronic ossifying periostitis at the attachments of the lateral ligaments or the capsular ligament (lateral, bilateral, circular ringbone). Articular ringbone, on the other hand, similar to spavin, is an osteoarthritis chronica deformans of the coronary-joint originating from an inflammatory osteoporosis of the subchondral bone of the first and second phalanges. There is an extension of the primary inflammatory process in the subchondral portions of these bones, which leads to a secondary degeneration of the articular cartilage, to an erosion of the cartilage, and finally to the formation of an anchylosis. This process is accompanied by a regenerative process in the bones (ostitis condensans). If the subchondral osseous inflammation extends in a centrifugal direction—in the direction of the periosteum—there further occurs an ossifying periostitis with the formation of osteophytes in the vicinity of the joint, that is, in addition to the articular, there is also a periarticular ringbone. As a rule, old cases of ringbone are a complication of the articular with the periarticular form. This also results in the development of an external anchylosis. Microscopically the first changes in the diseased bone consist of a dilitation of the Haversian canals, lacunar formation, the formation of red granulation-tissue, as well as atrophy of the bone-cells. (Cf: Udriski, "Die Krongelenkschale des Pferdes." Monatshefte für Praktische Tierheilkunde. 1900).

The same changes are found in the fetlock-joint (ringbone of the fetlock-joint), and pedal-joint (ringbone of the pedal-joint). (Cf: Kärnbach, "Die Hufgelenkschale des Pferdes." Monatshefte für praktische Tierheilkunde. 1900).

3. Chronic GONITIS of the horse, likewise, is usually an osteoarthritis, seldom a pure arthritis chronica

deformans. It usually attacks the medial portion of the knee-joint, and in most cases has its origin in the bones (tibia, femur) in the form of a primary rarefying ostitis. The inflammatory osteoporosis then extends in a central direction to the articular cartilage (erosion of the cartilage), in a horizontal direction to the periosteum of the bones on the sides of the tibia and the femur (formation of osteophytes), and finally to the joint-capsule (proliferation of the articular villi, hydrarthrosis, free joint-bodies). Chronic gonitis in the horse less frequently begins in the form of a primary chondritis (proliferation of the cartilage-cells, fibrillation and degeneration of the intercellular matrix), involving the bone in the form of a secondary process. (Cf: Zalewsky, "Die Gonitis chronica deformans des Pferdes." Monatschrift für praktische Tierheilkunde. 1901).

4. Chronic OMARTHRITIS in the horse is the most important cause of so-called chronic shoulder lameness. Its seat of origin is also usually found in the subchondral osseous tissue (medial half of the joint, marginal portion of the scapula) in the form of an inflammatory osteoporosis with a subsequent osteoschlerosis. As a result of extension to the articular cartilage there exists a chondritis with incurable cartilaginous erosion; nodular, warty, or crest-like exostoses form at the margins of the joint, occasionally these lead to a subsequent anchylosis formation; inner anchylosis, similar to spavin and ringbone, does not appear to occur. The joint-capsule is thickened, the articular villi are enlarged; occasionally it also leads to the formation of free joint-bodies. (Cf: Kärnbach, Die Omarthritis chronica deformans des Pferdes. Monatshefte für praktische Tierheilkunde. 1903).

The treatment of chronic deforming arthritis consists in allowing the natural process of healing to run its course (condensing ostitis), or in artificial adhesion (anchylosis) of the joint by means of rest, firing, or blisters. Neurotomy remains as a last resort.

4. TUBERCULAR INFLAMMATION OF JOINTS. ARTHRITIS GRANULOSA.

OCCURRENCE.—In cattle, swine, and birds, occasionally in dogs, there occurs a tubercular arthritis, as in man, during the course of tuberculosis. According to the anatomical characteristics it is termed granular, fungoid, spongy, and caseous arthritis, or caries of the joint; (tumor albus and fungus belong to older classifications). In cattle it is found in the knee-joints, hip-, elbow-, and carpal-joints; in swine in the carpus and tarsus; in birds in the joints of the feet and wings; one case has also been observed in the knee-joint of the dog (Cadiot).

ANATOMICAL CHANGES.—Tubercular arthritis is characterized by a granular inflammation with tubercular proliferations on the synovial membranes, cartilage, and bone; when continued for a long time there occurs a tubercular softening and liquefaction of the ends of the joints (caries), as well as caseation; occasionally the changes are typical of a deforming arthritis. Tubercle-bacilli are present in the proliferations and in the pathological synovia.

According to Guillebeau two forms of tubercular arthritis exist in cattle. Ordinarily the distended joint-capsule contains fibrin, the synovial papillæ are enlarged, sometimes to the size of a hazelnut or plum; many times they are flat, several centimeters in length and breadth, and of the nature of a pannous membrane. In the vicinity of the proliferations the articular cartilage is destroyed (ulcer-like defects); the articular epiphyseal ends of the bones are also eroded with the tubercular granulation tissue. Edema exists in the vicinity of the joint. Caseated tubercular nodules are less frequently observed in the synovial membranes and at the ends of the bones. One occasionally observes processes of healing (decrease in the fibrinous exudate and the hyperplastic membrane, formation of a cartilaginous cicatrix).

SYMPTOMS.—According to Hess tubercular arthritis occurs in cattle several weeks after parturition, as well as after an abortion. Its favorite seat is in the knee-joint (communi-

cation with the tendon-sheath of the long extensor of the toe) and in the elbow-joint. The disease frequently begins with a severe lameness and in most cases runs a chronic course. As a rule it is incurable and is associated with pronounced muscular atrophy. The diagnosis can be confirmed by means of a tuberculin injection.

ARTHRITIS FIBRINOSA.—Fibrinous or croupous inflammation of the joint is characterized by a serous exudate rich in fibrin, for this reason it is also termed a sero-fibrinous arthritis. On palpation the fibrin is recognized by a fine, crepitating sound (arthritis crepitans). By many, fibrinous inflammation of the joint is termed catarrhal arthritis (increased desquamation of the mucous villi), and is considered a mild type of suppurative arthritis (Volkmann). It frequently leads to anchylosis, occasionally to the formation of joint-bodies. It is found in tubercular arthritis of cattle (see above).

ARTHRITIS PANNOSA.—Pannous inflammation of the joints (arthritis chronica proliferans, or arthritis hyperplastica laevis) is a chronic arthritis characterized by the presence of newly formed vascular granulation-tissue on the surfaces of the articular cartilage. It is seen in chronic hydrops, during the course of a chronic articular rheumatism, and in tubercular arthritis of cattle (see above). Occasionally it leads to the formation of free joint-bodies (corpora libera), as well as to a fibrous anchylosis.

ARTHRITIS CHRONICA SICCA.—Dry or ulcerative inflammation of the joint (arthritis chronica ulcerosa) is observed in the horse after a chronic lameness as the result of a long period of rest for the joint; it is seen after a severe distorsion, as well as in the early stages of a deforming arthritis. It is characterized by fibrillation, disintegration and erosion of the articular cartilage. Horses and dogs are most frequently affected.

ARTICULAR RHEUMATISM.—This is a febrile, infectious disease accompanied by a serous polyarthritis; it occurs most frequently in cattle, less frequently in goats, swine, dogs, and horses. Usually several joints are suddenly affected with a very painful serous arthritis; its favorite location is in the carpal-, tarsal-, and knee-joints; it results in severe lameness. In cattle, especially, rheumatism of the joints is accompanied with inflammation of the tendon-sheaths. As in man, the development of endocarditis (valvular disease) forms an important complication. Though usually beginning as an acute or peracute disease, it ordinarily runs a chronic course. The anatomical changes in the joints consist largely of a serous or sero-fibrinous synovitis, as well as in inflammatory degenerative articular changes during a chronic course (arthritis pan-

nosa and deformans); a suppurative synovitis is seldom observed. As a rule the attack is simultaneous in several joints. In the acute course one finds the synovial membrane highly reddened, even hemorrhagic, turbid, swollen and thickened, the articular papillæ are vascular and enlarged. The amount of the synovial fluid is increased, reddish in color, and often cloudy. In the early stages the articular cartilages are very red; later they become yellow and present a rough, velvet-like surface. The tissues in the vicinity of the joint also present an injected appearance, they are permeated with hemorrhages and infiltrated with serum (periarthritis); the connective tissue, especially, is affected with a gelatinous swelling, the adjacent muscles are edematous and soft. The articular ends of the bone are hyperemic and even infiltrated with hemorrhages; the same is true of the bone-marrow. In the chronic type the synovial membrane becomes markedly thickened, and the inner surface of the joint is covered with a vascular connective-tissue layer (arthritis pannosa); the articular cartilage undergoes fatty degeneration, presents ulcerative losses of substance, and becomes partly loosened. In other cases there develops, as in man, an arthritis deformans. In dogs suffering from articular rheumatism there have been observed adhesions between the bones of the carpus and metacarpus, as well as irregular osteophytic formations. General changes occasionally occur in the body in the form of an endocarditis, pleuritis and peritonitis. Treatment is internal. It consists in the administration of large doses of natrium salicylicum (horses and cattle 100 grams, dogs 2 to 8 grams, per day), salol, antifebrin, antipyrin, salipyrin, etc. (see articular rheumatism: Friedberger and Fröhner, "Special Pathology of the Domestic Animals," 1904, 6 Ed., Vol. I).

Pyemic and Septic Arthritis of Young Animals.—Pyemic and septic polyarthritis, formerly known as "foal-lameness", (foals, calves, lambs, pigs, puppies) develops metastatically from a septic infection of the navel-wound; it is the result of improper care of the navel. Staphylococcus pyogenes aureus (Sohnle), and streptococcus pyogenes (Ostertag) have been demonstrated as the infectious irritant. A few days or weeks after birth there develops an omphalitis with suppurative thrombophlebitis and thromboarteritis which soon leads to a general infection of the body (septicemia, pyemia). After previous febrile symptoms of a general disturbance swellings develop rapidly and simultaneously on several joints, especially the carpus, tarsus, knee, elbow, and hip; the swellings are accompanied by lameness and finally lead to abscess formation. Most animals die in the course of two or three weeks from septic diarrhea or internal pyemic metastases. On post mortem one finds lesions of a suppurative, sero-purulent, or sero-fibrinous polyarthritis, in addition to changes characteristic of pyemic processes (pyemic form); in other cases the changes are more typical of septi-

cemia (septic form). When the navel-wound is not already healed it shows traces of inflammation and suppuration, the umbilical cord and the tissues surrounding the umbilicus are swollen, the margins of the umbilical ring present ulcerative thickenings, abscess formation has taken place within the umbilical ring, drops of pus may be pressed out of the umbilical opening. In addition to this omphalitis, which may also heal, so that it presents no external symptom of disease, there exists in the deeper tissues a suppurative thrombophlebitis and thromboarteritis umbilicalis with thrombosis of the portal vein and its hepatic branches. The synovial membranes of the joints are injected, swollen, and thickened; the fluids of the joints are cloudy, increased in amount, mixed with a floculent coagulum, and are often purely suppurative in character (empyema of the joint); the articular cartilages undergo ulcerative degeneratio n; at times the bone itself becomes necrotic; occasionally the joint-capsules are perforated. Suppurative osteomyelitic foci are found in the bones. Abscesses form between the muscles and tendons in the vicinity of the joint, the muscles may even undergo suppurative liquefaction. The muscles over the diseased joint are affected with fatty degeneration. The most typical examples of this disease are seen in the knee-, tarsal-, and occipito-atloid articulations. In addition, post mortem examination reveals metastatic foci in nearly all the organs, especially in the liver, lungs, and brain, the kidneys, in the muscles, and in the subcutaneous cellular tissues. In the liver these foci are from the size of a millet-seed to that of a cherry and larger, in the lungs from the size of a millet-seed to that of a hen's egg; in the early stages they are dark-red, afterwards becoming yellow (so-called suppuration of the lungs). The following diseases have also been observed: pleuritis, endocarditis, pericarditis, bronchopneumonia, inflammation of the tendon-sheaths, peritonitis, cystitis, suppurative iritis, panophthalmia, leptomeningitis, etc.—Treatment is essentially prophylactic: disinfection of the umbilicus and stall, ligation of the umbilicus. (For further information see: Friedberger and Fröhner, "Special Pathology of the Domestic Animals". 1904, 6 Ed., Vol. I).

ARTHRITIS URICA.—This is an arthritis due to the presence of urates in the joints (gout). It is a metabolic process the nature of which is not yet fully understood; it occurs in man and birds, and occasionally in dogs.

PERIARTHRITIS.—Periarthritis is an inflammation of the soft tissues surrounding the joint, especially the periosteum; the points of attachment of the capsular and lateral ligaments, the posterior ligaments, and the suspensory ligaments, the neighboring tendon-sheaths, and mucous bursae, as well as the

parasynovial connective tissue. A form of periarthritis which is of great practical importance in the horse is that type which frequently attacks the insertions of the lateral ligaments and the capsular ligament at the coronary joint, designated as so-called periarticular or false ringbone (see page 241); the carpal tumors (false tumor albus), described as a schlerotic inflammation of the periarticular connective tissue, the tendon-sheaths, and the subcutis of the carpal-joints of cattle; as well as many alleged inflammations of the tarsal-, fetlock-, coronary-, and pedal-joints in the horse. According to Siedamgrotzky ninety per cent of all cases diagnosed as inflammation of the phalangeal joints are periarthritis—that is inflammation of individual groups of ligaments without involving the synovial membranes or the articular surfaces. The following groups are frequently implicated: the internal and external lateral ligaments of the pedal-joint, the external and internal suspensory ligaments of the navicular bone and lateral cartilages, the lateral navicular ligaments, the lateral ligaments of the second phalanx, as well as the suspensory apparatus of the first phalanx. Kärnbach has demonstrated that genuine chronic deforming arthritis of the pedal-joint (ringbone of the pedal-joint) is not uncommon.

II. CHANGES IN POSITION OF JOINTS. LUXATION, DISTORSION, CONTUSION.

1. LUXATION OR DISLOCATION.

DEFINITION.—Luxation or dislocation is a persistent separation of both articular ends after overcoming the restraining mechanism. If the dislocation is only partial so that the articular surfaces are not completely separated, it is termed a subluxation or incomplete luxation. A simple dislocation, in contrast to a complicated, is not accompanied by severe injuries, especially fractures. One further recognizes a recent and old, as well as recurrent or habitual luxation. Diastasis is a term which designates a luxation of a false joint or half-joint, for example, the sacro-iliac joint in cattle. Formerly a change in position of the lens was termed luxatio lentis; that of the bulb, luxatio bulbis.

CAUSES.—One distinguishes traumatic, spontaneous or pathological, and congenital luxations.

a) Traumatic dislocations are due to the influence of external forces; they may be indirect through abnormal flexion, extension, or rotation of the articular ends by means of a leverage; or direct, as the result of kicks and blows. Occasionally luxations in horses are due to muscular force, for example, the patella may be dislocated upwards as a result of severe contraction of the quadriceps femoris when the animal is kicking. One most frequently observes traumatic luxations of the hip-joint in dogs and cattle (less frequently in horses); of the cervical vertebræ in horses and dogs; of the patella in horses; of the inferior maxilla in carnivora, as well as of the elbow-joint in puppies. Dislocation of the fetlock-joint in race-horses is seemingly rare.

b) Spontaneous or pathological luxations are due to disease or inflammation of the joint, atony or abnormal stretching of the joint-capsule and articular ligaments, hydrops of the joint, flattening of the articular condyles, as well as deforming arthritis. Habitual luxation of the patella in the horse is an example of this class. In human surgery various forms of pathological dislocations are recognized: distention-luxation occurs in hydrops of the joint as a result of stretching and atony of the joint-capsule and articular ligaments; destruction-luxation after suppurative liquefaction of the articular ends (joint-caries); deformation-luxation as a result of deforming inflammation of the joint (loose-jointed).

c) Congenital luxations are usually due to arrested development; they seldom occur during birth as a result of faulty manipulations. In many cases it is difficult to determine whether luxation of the patella in the horse is due to a congenital or acquired flattening of the articular surface of the internal condyle of the femur, or to congenital and acquired overextension and atony (distorsion) of the joint-capsule and articular ligaments, with enlargement of the articular cavity.

Symptoms.—Luxation of the joints of the extremities is characterized by lameness, as well as by restriction, or abnormally free movement of the dislocated

joint. In upward luxation of the patella, for example, the knee-joint is abnormally extended and cannot be flexed; external luxation, on the other hand, results in excessive flexion, the limb is unable to support weight. Luxation of the inferior maxilla in dogs is characterized by inability to close the mouth. Upward luxation of the femur results in shortening of the affected limb. In dogs the decrease in length may be easily determined as follows: with the animal in the standing position extend the knee-joints equally and compare the positions of the tarsi or the paws. Inspection and palpation of the articular ends and comparison with the normal joint of the opposite side are also important diagnostic methods. In upward luxation of the right femur of the dog, the trocanters, especially the greater trocanter, are higher than those of the opposite side; this is readily determined by inspection or by palpation with the thumbs. The other changes in the form of the joint, as well as the changed position of the dislocated bones, and the changed position of the entire limb, may indicate the presence of a dislocation. In general a dislocation may be differentiated from a fracture by the absence of crepitation.

Complicated luxations may be associated with fracture of the dislocated bones, especially the glenoid margins of the hip-joints, the cervical vertebræ, and the occipital bone; or with severe injuries to vital organs, especially the spinal cord in luxation of the vertebral column; or finally, with laceration of the skin and the soft tissues surrounding the joint. In animals rupture of the skin seems to be uncommon. Smith describes a case of luxation of the fetlock-joint in the horse in which the metacarpus penetrated the skin and was driven into the ground to a depth of four inches.

Diastases are observed in cattle at the sacro-iliac joint and at the pubic symphysis, and in the vertebral column of horses as a result of rupture of the intervertebral ligaments. Complete diastasis of the sacro-iliac joint results in a detachment of the tense, almost immoveable union between the sacrum and the ilium, so that the sacrum sinks downwards and results in stenosis of the pelvic canal. On rectal examinations the

promontory is found to be directed downwards; viewed from without the vertebral column seems to have dropped while the internal angles of the ilium are abnormally prominent. Diastasis of the pubic symphysis may also be recognized from the rectum. In horses rupture of the sacro-iliac ligaments results in a form of so-called sacral weakness or sacral paralysis.

ANATOMICAL CHANGES.—Luxations, with the exception of the patella, usually result in laceration of the capsule, and partial or complete rupture of the lateral and accessory ligaments. Luxations of the hip-joint are characterized by rupture of the capsular ligament and usually a rupture or tearing away of the round ligament. Rupture of the joint-capsule leads to hemorrhage within and around the joint; rupture and hemorrhage may also occur in the neighboring soft tissues, muscles, connective tissue, etc. Fractures are also observed, especially on the acetabular margins of the hip-joint. Spontaneous luxations are characterized by chronic inflammatory changes in the joint.

If reposition of the dislocated joint-surfaces is not produced a new joint is formed in the vicinity of the dislocated ends (nearthrosis). In the vicinity of the hip-joint, especially, the proximal extremity of the dislocated femur is surrounded by an inflammatory tissue formation which is very similar to a joint-capsule; at the same time a new acetabulum with a cartilaginous covering results from proliferation of the periosteum of the pelvis. Nearthrosis formation is most frequently observed after dislocation of the hip-joint in dogs; it is occasionally observed in horses. In a horse affected with chronic hip-lameness Kitt found the following conditions: A loose, one half to two centimeters thick, connective-tissue sac, which performed the function of a joint-capsule in the region of the acetabulum; enlargement of the joint-cavity in the direction of the shaft of the ilium; the articular surface of the femur was worn smooth.

TREATMENT.—As in fractures, treatment of dislocations consists on the one hand, in reposition; on the other, in retention of the dislocated ends. Healing depends on these fundamental principles. Recent simple luxations heal rapidly

when both conditions are fulfilled; the ruptured capsule is soon closed, the intra- and extracapsular hemorrhage is rapidly resorbed. Unfortunately, with the exception of a dislocated patella, reposition and retention is more difficult in animals than in man. Reposition of the hip-joint, in particular, is very difficult in well muscled horses and cattle, even with a set of pulley-blocks it is not always possible to overcome the mechanical resistance; the application of a retention bandage is also more difficult than for fractures. Retention of a reduced hip-joint is not easy to accomplish even in dogs, as they will not remain quiet. Relatively speaking the following luxations are most easily reduced: the patella and first phalanx in the horse, and the inferior maxilla in the dog. In all old luxations, of which luxation of the hip-joint in the dog is a frequent example, no experiments with reposition and retention are made; even apparently severe dislocations of the articular head develop very rapidly into a nearthrosis, so that the limb can be used again in a relatively short time. I have also observed one case of spontaneous healing in luxation of the hip in a horse. Arthrotomy and resection of the joint, as employed in human surgery, is not usually applicable for domestic animals (in the horse I have twice performed resection of the maxillary-joint with good results). The success and results of separation of the internal lateral ligament of the patella, for upward dislocation of that bone, are yet to be demonstrated.

STATISTICS OF LUXATIONS.—1. In the horse the number of luxations is small when compared with other abnormal positions of the joints, especially distorsions; the same is true when compared with other diseases of the joints. There is an average of about one luxation to fifty distorsions. In a thousand cases of diseases of the joints, there is about one luxation. The following statistics are compiled from the military records of the Prussian Army: In ten years, 1886–1897, of 300,000 diseased horses in the service, over 36,000 cases included affections of the joints; of these, 15,000 were distorsions, while only 320 were luxations. With reference to the occurrence of luxations in different joints, statistics indicate that the patella is by far the most frequent seat. The fetlock-joint is second. Of 7,000 horses brought to the Berlin Surgical Clinic, I have observed only five luxations of the femur, as as well as two luxations of the patella and fetlock-joint.

2. Luxations are much more frequent in dogs than in horses. Of the 70,000 dogs treated by me in the Berlin Dog Hospital during a period of nine years (1886–1895) there were 344 luxations (equal to 0.5 per cent of all the cases) and 579 distorsions (equal to 0.8 per cent of all cases). As a rule, in dogs the dislocation is at the hip-joint.

2. DISTORSION OR SPRAIN.

NATURE AND SYMPTOMS.—A distorsion or sprain is a momentary separation of two articular surfaces in contrast to a permanent deviation of a luxation. As in luxations, they are designated as simple and complicated, that is, combined with severe injuries, especially fractures.

The causes of distorsion are the same as those of dislocation, they vary only in degree, less force is exerted. The anatomical changes in the joint are essentially the same as those accompanying dislocations. Simple distorsions lead to stretching and even laceration of the joint-capsule and the ligaments of the joint, as well as to hemorrhage within and outside the joint. These conditions often account for the chronic course of many distorsions; if a fracture also exists the distorsion may be incurable as joint-fractures are not amenable to treatment.

The symptoms consist in sudden lameness, as the causes are usually due to an overstretching or forcible rotation (oblique position, knuckling over, being caught in the rails, etc.). Palpation of the joint by means of passive movements, especially rotation, produces severe pain; in addition, there is increased heat and swelling in the joint (very frequently this is visible only after twenty-four hours). Because of these symptoms, which are also characteristic of inflammation of the joint, the case may be diagnosed as arthritis instead of distorsion. Crepitation and abnormal mobility, as well as permanent changes in position are not present in simple distorsions; on the other hand, crepitation may accompany complicated distorsions.

The course varies according to the severity of the anatomical changes. If there is only a slight overextension

of the joint-capsule and articular ligaments, without a rupture of the same, lameness may disappear in a few days. If, however, the joint-capsule is severely ruptured, the articular cartilage bruised, and extensive hemorrhage has taken place within and outside the capsule, healing requires several weeks or even months. There develops a chronic, partly ulcerative, partly deforming arthritis (ringbone for example), and even anchylosis of the joint so that healing becomes impossible. As has been remarked, complicated distorsions are often incurable. For these reasons the prognosis of any distorsion should be given with caution.

TREATMENT.—Recent distorsions are treated with rest, moist heat in the form of Priesnitz compress, massage, compression, and plaster-of-Paris bandage. If the healing of distorsions is delayed, two or three weeks for example — if the lameness still remains — blisters and firing may be employed. Neurectomy remains as a last resort for incurable cases.

STATISTICS OF DISTORSIONS.—In horses, distorsions of the joint form one of the most frequent of joint-diseases. About half of all joint-diseases are distorsions. In the horse the fetlock-joint and coronary-joint are most frequently sprained. According to the statistics of the Prussian Army, which are in harmony with the estimates of Stockfleth and Bayer, distorsions of the fetlock-joint are far more frequent than those of the coronary-joint. According to the Prussian Military Reports, in the years 1890–1897, there were 6000 distorsions of the fetlock-joint and only 2100 of the coronary-joint. In the year 1900, of 1900 cases of distorsion, 1100 involved the fetlock-joint and 600 the coronary-joint. In the year 1901 there were 940 distorsions of the fetlock-joint and only 611 of the coronary-joint. In contrast to this, Möller and Frick maintain that distorsions of the coronary-joint are more frequent. According to my own experience, distorsions of the fetlock are more frequent than those of the coronary-joint; of 120 distorsions examined (1895–1898), 70 were of the fetlock-joint, 50 of the coronary-joint. Both joints are often involved at the same time.

3. CONTUSIONS OR BRUISES OF THE JOINT.

NATURE AND SYMPTOMS.—A joint contusion is a bruising of the joint; it may occur directly by means of pressure,

blows, and kicks directly over the joint, or indirectly by means of concussions and shocks which are operative at some point below the joint and result in compression of the articular surfaces. In the first case there exists a contusion and inflammation of the capsular ligament and the periarticular tissue; in the latter, a contusion of articular cartilage, which in severe cases may be associated with a fracture of the articular ends.

The symptoms of joint contusion are similar, though lesser in degree, to distorsions. The lameness in particular, and the amount of pain shown on palpation, are less than in luxation. On the other hand, contusions usually lead to severe hemorrhage into the joint (hemarthrosis), as well as to a large fluctuating swelling in the vicinity of the joint (contusion-swelling of the skin and subcutis).

The course is usually more favorable than that of distorsions; ordinarily resorption of the blood-extravasate in the joint is rapid; function is entirely restored. At times a hydrops of the joint may remain (joint-gall). The course is unfavorable only when the contusion is complicated with a fracture or joint-wound.

TREATMENT.—Early massage and compression of the joint by means of a permanent or elastic bandage is the most appropriate treatment for contusions of the joint. Resorption may be favored by moist heat, and later with slight exercise.

III. ANCHYLOSIS AND CONTRACTURE.

1. ANCHYLOSIS OR STIFF JOINT.

DEFINITION.—Anchylosis is an adhesion between two articular surfaces; it results in stiffness and immobility of the joint. In contrast to contracture of the joint, in which the mobility is only restricted, anchylosis implies a complete suspension of the motion. According to the character of the connective substance at the point of adhesion, anchylosis is designated as follows: osseous, cartilagi-

nous, and connective-tissue anchylosis (anchylosis ossea, cartilaginea, and fibrosa). Anchylosis ossea is sometimes erroneously termed synostosis. According to the location of the anchylosed masses within or outside the articular capsule, it is termed inner and outer (intracapsular and extracapsular) anchylosis. There is also a genuine and a false (apparent) anchylosis.

CAUSES.—Anchylosis formation is either the product of a chronic arthritis, especially the deforming, pannous and granular types, or it is the result of a fracture involving the joint. It is most often seen during the course of a deforming arthritis (spavin, ringbone); in ossifying periostitis in the vicinity of joints; as a result of periarthritis at the carpal-joint; following ossification of the intervertebral cartilages in old horses (causes of constrained movement in the saddle-region and of fractures of the vertebræ); as a result of poll-evil, which leads to adhesions between the cervical vertebrae and permanent stiffness of the neck; and in chronic inflammatory conditions of the inferior maxillary-joint. Occasionally one finds the inferior surface of the vertebral column of the horse covered with osseous proliferations from the size of a hazelnut to that of a hen's egg; they are so closely bound together that the vertebræ form a strong, immoveable column (saddle constraint). Adhesion between the eyelids, which is analogous to that between joints, is termed anchyloblepharon.

TREATMENT.—In the domestic animals anchylosis is usually incurable. When a joint is anchylosed the mobility, pain, and lameness are suspended; for this reason, in veterinary medicine, certain chronic inflammations of the joint, especially spavin and ringbone, are treated with blisters and the cautery in an attempt to produce artificial anchylosis of the joint. In man, anchylosis is treated in the early stages with massage, passive movements and extension of the joint under the influence of narcosis in an attempt to prevent permanent stiffness. Complete anchylosis is treated with resection of the joint, arthrotomy and osteotomy.

2. JOINT CONTRACTURE (STILT-FOOT).

DEFINITION.—The expression "contracture" designates an abnormal position of the joint in which freedom of movement is permanently restricted (knuckling of the joint, stilt-foot). This should not be confused with contraction, that is, excessive muscular contraction.

CAUSES AND FORMS.—Restriction of the mobility of the joint may be due to the following causes: diseases of the joints, tendons, muscles, nerves, and skin, or it may be congenital. One designates, therefore, the following forms of contracture: articular, tendinous, myogenic, neurogenic, cicatricial, and congenital contractures.

a) Articular contractures are due to pathological conditions of the joint itself, there is a restriction of the free mobility of the joint (articular stilt-foot). It may result from any of the following conditions: exostosis formation and irregularities on the articular surfaces, inflammatory new-formations in the joint itself, arthritis deformans, free joint bodies, first stages of anchylosis. In the horse one most frequently observes an articular contracture (articular stilt-foot) during the course of an articular ringbone, the osteophytic enlargements on the first and second phalanges, as well as the first stages of anchylosis, mechanically restrict free movement in the coronary-joint. The same condition is observed in unilateral chronic arthritis of the maxillary-joint which results in imperfect mastication on the side involved.

b) Tendinous contractures are due to contraction and adhesion of the flexor tendons; they follow a tendinitis (tendinous stilt-foot). In adult horses tendinous contractures are most often observed at the anterior fetlock-joint (knuckling in a narrow sense) as a result of chronic inflammation of the perforans tendon.

c) Myogenic contractures are due to cicatricial retraction of muscles as a result of previous ruptures and inflammations. Contracture of the internal and external flexors of the carpus (flexor, and extensor carpi ulnaris) produces so-called

"knee sprung" in horses. Contracture of the mastoideo humeralis results in an oblique position of the neck (caput obstipum). Unilateral contracture of the lateral coccygeal muscles causes the tail to be held to one side. Apparently many cases of acquired stilt-foot in colts are referable to a myogenic cause (rheumatism, rachitis).

d) Neurogenic contractures result from derangements of the muscular innervation, they are due, either to paralysis and muscular weakness (paralytic neurogenic contracture), or to cramps in certain groups of muscles (spastic neurogenic contracture). Congenital stilt-foot in foals (so-called knuckling) is due to a paralytic contracture (congenital weakness of the extensor muscles). This hypothesis explains the rapid recovery from stilt-foot in foals under proper treatment. The relative ease with which it may be cured does not sustain Johne's hypothesis. He maintains that stilt-foot in foals is a tendinous contracture resulting from a faulty position of the flexor tendons in utero.

e) Tissue or cicatricial contractures result from tissue-contraction following a wound, burn, cauterization and necrosis of the skin on the flexor surfaces of joints, as well as on the neck (caput obstipum). Therapeutics of this affection involves the same treatment as that employed in the operative treatment of entropion in dogs: cutting out a piece of skin (blepharoplasty).

f) Congenital contractures depend, either upon a congenital muscular weakness (stilt-foot in foals), or upon a deranged development of the joints of the fetus. The latter conditions in domestic animals do not receive surgical treatment because young animals thus affected are not allowed to live. The following congenital forms of club-foot are recognized in man: (pes varus) an arthrogenous supination-contracture of the foot; flat-foot (pes valgus or planus), an abnormal dorsal flexion of the foot; horse-foot (pes equinus), an abnormal planter flexion of the foot. Genu valgum (x-formed limb) also occurs.

TREATMENT.—Many cases of contracture are incurable; by means of an operation many are partially curable. This is

especially true of tendinous contractures (tendinous stilt-foot) which may be benefited by tenotomy; and myogenic contractures (knee-sprung, crooked tail) which are occasionally improved by performing myotomy. The neurogenic contractures also (stilt-foot of foals) sometimes recover when properly bandaged and massaged. Articular contractures (ring-bone), on the other hand, are incurable, even neurectomy is ineffective because restricted mobility is due to mechanical causes.

DEFORMITIES OF THE VERTEBRAL COLUMN.—The following types of deformities of the vertebral column are sometimes congenital: kyphosis (hump-back, carp-back); lordosis (hollow-back); scoliosis (lateral curvature of the spine); occasionally a combined form is seen (kyphoscoliosis). Bayer has described two cases in the horse, one to the left, the other to the right. Other cases have a rachitic origin (see page 230). In mares, lordosis may result from repeated pregnancy, it may also result from pressure on the spinal column. According to Johne the vertebral column of cattle may occasionally rotate slightly on its long axis as a result of chronic tympanitis of the rumen (tuberculosis of the mediastinal glands).

Deformities of the vertebral column may also be due to fractures, chronic inflammatory processes in the intervertebral joints, tuberculosis and new-formations. Hess has described a case of kyphosis in a steer that was caused by tuberculosis of the lumbar vertebræ. An interesting case of dorso-lumbar curvature in the horse has been described by Vatel. The curvature of the spine had dislocated the kidneys, the posterior aorta was displaced downwards and dilated to form an aneurysm. The lumbo-sacral joint was affected with arthritis sicca and erosion of the cartilage, a bony tumor lay between the seventeenth and eighteenth ribs, the articular surfaces of the lumbar vertebræ were anchylosed. Goubeaux has furnished an extensive work on "Deformitäten der Wirbelsäule bei den Haustieren." (Recueil. 1886-87).

IV. JOINT BODIES. CORPORA LIBERA.

NATURE.—Joint-bodies (free bodies, corpora libera, joint-mice, mures articulorum, rice-like bodies, corpora oryzoidea) are free or pedunculated smooth bodies situated in the joint-cavity. They vary in size from a millet-seed to that of a cucumber-seed, and are seldom as large as a dove's egg, they have a white glistening color, and are of the consistency of cartilage or bone. Their origin is extremely variable:

1. Arthritis deformans and osteochondritis dessicans (coagulation necrosis) form the most frequent causes of joint-bodies; circumscribed particles of the articular cartilage are sloughed off.

2. Others are the product of an inflammatory swelling and a connective-tissue cartilaginous and osseous proliferation of the articular villi, especially the cartilaginous villi, which are subsequently torn away or constricted.

3. Others occur from sloughing away of pieces of cartilage or bone in complicated distorsions, luxations and contusions of the joint.

4. Many are formed by coagulation and organization of masses of fibrinous exudate (corpora oryzoidea).

5. In rare cases extracapsular new-formations (exostoses, lipoma) grow into the joint-cavity and become constricted.

SYMPTOMS.—The occurrence of these foreign bodies is very rare. When they are suddenly brought between the articular surfaces the following symptoms may result: lameness, which develops suddenly without any apparent cause, and as suddenly disappears, remittent lameness. Diagnosis during life is extremely difficult. Stockfleth found corpora libera in the knee- and tarsal-joints of the horse; Bruckmüller in the shoulder- and carpal-joints; Möller found a body as large as a dove's egg in the knee-joint of a horse.

Treatment in the horse is impossible. In dogs, as in man, arthrotomy may be tried.

DISEASES OF THE TENDONS, TENDON-SHEATHS, AND MUCOUS BURSÆ.

PRELIMINARY REMARKS ON ANATOMY AND PHYSIOLOGY.

TENDONS.—The tendons consist of fine tendon-fibrillae which are bound by a cement-like substance into slender tendon-fibers. Through the adhesion of numerous tendon-fibers tendon-fasciculi (primary tendon-bundles) are formed. Several fasciculi are surrounded by epitendineum to form secondary bun-

dles; epitendineum is a loose connective-tissue layer containing a few blood-vessels. The secondary bundles are combined in a similar manner to form tertiary tendon-bundles out of which the tendon is composed. The surface of the tendon is covered with paratendineum, a loose connective-tissue layer. From a surgical standpoint the following tendons are of great practical importance: the flexor tendons of the phalanges; namely, the suspensory ligaments (superior sesamoid ligament), the flexor perforans and perforatus. The anatomy and physiology of the tendons under consideration, which may be regarded as supporting ligaments of the phalangeal joints, are of great importance for an understanding of the pathogenesis, symptomatology, and therapy of diseased tendons. A valuable contribution to this knowledge has recently been supplied by Stoss (Anatomie und Physiologie der Phalangenbänder des Pferdes. Monatshefte für praktische Tierheilkunde, 1895). According to this article the flexor of the first phalanx (so-called superior sesamoid ligament) is primarily a volar interosseous muscle, flexor of the first phalanx, and the most highly developed type of supporting ligament, it prevents overextension of the fetlock-joint (so-called dorsal flexion of the fetlock-joint). The flexor of the first phalanx is attached to the postero-superior extremity of the metacarpus at one end and to the sesamoid bones at the other. In the same manner the flexors of the second and third phalanges form supporting ligaments for the coronary- and pedal-joints. The so-called check ligaments of the same prevent overstretching of the flexor muscles from the body weight, and perform the same function for the coronary- and pedal-joints as that performed by the suspensory ligament for the fetlock-joint. The check ligament of the flexor perforans arises from the thickened posterior capsule of the carpal-joint; that of the flexor perforatus from the radius above the carpal-joint.

TENDON-SHEATHS AND MUCOUS BURSÆ.—For surgery, the anatomy or tendon-sheaths and mucous bursæ is extremely important. In most text-books on veterinary anatomy the arrangement is neither detailed nor distinct. The following is a short description of the most important relations in the horse according to Eichbaum (Berlin Archiv. 1883). The physiological function of tendon-sheaths and mucous bursæ consists in facilitating the gliding movements of the tendons, muscles, and skin, especially where they pass over projecting areas. The physiological function has a common relation to the anatomical and histological structure; they vary only in external form. They may fuse with one another, they have no constant structure, and they may communicate with joints (for example, the tendon-sheath of the extensor digitorum communis with the knee-joint); further, mucous bursæ may develop into tendon-sheaths.

The tendon-sheaths (bursæ vaginalis, vaginæ tendineum) form cylindrical sacs which isolate the tendons by means of sheath-like coverings at points where they pass over extensor or flexor surfaces of articulations. Occasionally several tendons are enclosed in one sheath, namely, the tendons of the perforans and perforatus at the posterior surface of the carpus and metacarpus. Similar to joint-capsules the tendon-sheaths are lined on their inner surfaces with synovial membranes (serous sheath, mucous sheath), which represent serous membrane, in that they are lined with a single layer of endothelium (by others, they are regarded as glandular, mucus secreting organs). The external layer of the tendon-sheath has a fibrous covering which is bound to the synovial membrane by means of connective tissue.

The mucous-bursae (bursæ mucosæ) form round sacs flattened laterally; they are situated beneath tendons, muscles, and skin; their inner walls are usually smooth, sometimes rough and net-like from papillæ and projecting tendon-fibers, or they have the appearance of a fenestrated membrane. Two forms of mucous bursæ are recognized. 1. Bursae mucosae subtendinae (bursæ subtendinæ), which, because of their seemingly constant occurrence, are also termed "typical" mucous bursæ. They are situated at the points of origin and insertion of muscles and tendons, beneath these organs and in close contact with them. Like tendon sheaths, their inner surfaces are covered with a layer of endothelium; in old horses they frequently communicate with tendon-sheaths and joints, in these cases they form a blind, sac-like protrusion of the joint-capsule (bursæ synovialis). The existence of this combination is of great importance in certain surgical affections (galls). Bursæ subtendinæ are usually present in foals. The following are of special surgical importance: the bursa intertubercularis of the biceps in front of the shoulder-joint, and the subtendinous bursa of the flexor perforatus at the calcaneum. 2. Bursae mucosae subcutanae (bursæ subcutanæ), because of their inconstant occurrence, are also termed "atypical" mucous bursæ; they develop after birth ("acquired" mucous bursæ) and increase in number with the age of the animal. Apparently their origin is due to ruptures of the subcutaneous connective tissue; this is produced by extension and flexion of the joint, especially through laceration of the subcutis over osseous tuberosities; laceration leads to encapsulation. The inner surfaces of these acquired mucous bursae contain, therefore, in most cases, no endothelial layer. They are found in all places where the skin is moveable over osseous tuberosities, especially on the olecranon (shoe-boil), calcaneum (capped-hock), and on the external angle of the ilium. They are less frequently seen in the following places: on the patella, malleoli, withers, sacrum, and on the extensor surfaces of joints.

The following mucous bursae and tendon-sheaths are of great surgical importance:

I. HEAD.—The subcutaneous bursae on the crest of the occipital bone (neck-tumors in dogs).

II. NECK.—The bursa mucosa beneath the origin of the ligamentum nuchae, between the cervical ligament and the superior surface of the atlas and its capsular ligament. It varies in length from three to ten centimeters, is oval in form, and bounded laterally by the middle extensors of the head. A second bursa mucosa is situated beneath the cordiform portion of the ligamentum nuchae in the region of the second cervical vertebra; it is about the size of an apple, and lies between the cordiform portion of the cervical ligament and the points of attachment of the lamellar portions of the cervical ligament to the crest of the second cervical vertebra. It is bounded on both sides by the complexus muscles (poll-evil in horses).

III. TRUNK.—A mucous bursa lies above and on both sides of the withers (fifth to seventh dorsal vertebræ, fistulous withers). There is a mucous bursa over the external angle of the ilium—bursa iliaca lateralis—both upon the superior and the inferior tuberosities of the same; the superior is ten centimeters long, and four to five centimeters wide. A third mucous bursa lies on the tuberosity of the ischium—bursa tuberis ischii—it is the size of a walnut (hygroma formation).

IV. ANTERIOR EXTREMITIES.—A subtendinous bursa lies under the insertion of the infraspinatus muscle (bursitis infraspinati). A bursa mucosa lies between the tendinous origin of the biceps brachii and the trochlea of the humerus—bursa intertubercularis—(bursitis intertubercularis). A very important bursa mucosa lies on the posterior surface of the olecranon process of the ulna, bursa olecrani; it is very common, from the size of a walnut to that of an apple, it has vaginal walls and several compartments; occasionally it is situated more on the lateral side of the olecranon process of the ulna (shoe-boil). The following are important: the tendon-sheath of the extensor pedis on the anterior surface of the carpal-joint; the tendon-sheath of the extensor suffraginis (at the same place); the tendon-sheath of the middle extensor of the carpus; the tendon-sheath of the oblique extensor of the carpus; the tendon-sheath of the external flexor of the carpus (M. extensor carpi ulnaris); a subcutaneous bursa mucosa on the anterior surface of the carpal-joint in cattle ("knee tumor"); the tendon-sheath of the perforans and perforatus, this is very large, situated largely in the carpal sheath, it begins about ten centimeters above the carpal-joint and passes downwards as far as the point of attachment of the check ligament to the perforans tendon (galls of the flexors at the carpus), tenotomy should be performed below this tendon-sheath; the tendon-sheath of the flexor of the

carpus (M. flexor carpi radialis); the bursa mucosa on the anterior surface of the inferior extremity of the metacarpus and metatarsus; the common tendon-sheath of the flexor perforans and perforatus, it begins ten centimeters above the fetlock-joint, passes over the posterior surface of the superior sesamoid ligament, the sesamoid bones, the first and second phalanges, and ends at about the middle of the second phalanx (perform tenotomy above this tendon-sheath); the bursa mucosa subtendinea on both lateral surfaces of the first phalanx.

Finally, the bursa podotrochlearis is of great importance, this is a mucous bursa beneath the insertion of the perforans tendon; it begins at the posterior margin of the navicular bone and reaches to the pedal attachment of the flexor perforans. It forms a closed sac that does not communicate with the pedal-joint; the anterior wall covers the posterior surface of the navicular bone, while the posterior wall is in contact with the flexor tendon (bursitis podotrochlearis).

V. POSTERIOR EXTREMITIES.—The bursa glutei medii (trochanterica) is a mucous bursa beneath the end insertion of the gluteus medius and maximus on the middle trocanter; it forms a circumscribed sac on the outer smooth surface of the middle trocanter (bursitis trocanterica). At the knee-joint is situated the bursa mucosa subcutanea in front of the patella (bursa prepatellaris), it is present in only fifty per cent of all horses, and varies in size from that of a bean to that of a walnut. It is located on the anterior surface of the patella, usually on the projecting upper half, and occasionally extends to the lateral border of the patella (bursitis prepatellaris). There is also a mucous bursa on the tibia beneath the insertion of the middle straight ligament of the patella, bursa subpatellaris (bursitis subpatellaris). The following are of practical importance: the synovial bursa beneath the origin of the flexor metatarsi and long extensor of the toe, about fourteen centimeters long, large, it is located immediately below the knee and communicates with the knee-joint; the bursa mucosa subcutanea above the tuberosity of the calcaneum—bursa calcanei, this is very common, though not constant, oval in form, four to five centimeters long, three to four centimeters wide, and lies on the posterior surface of the upper end of the calcaneum (capped-hock); the tendon-sheath of the lateral extensor of the toe, this begins two to four centimeters above the lateral maleolus and terminates on the upper surface of the metatarsus (string-halt operation); the tendon-sheath of the long extensor of the toe passes over the anterior surface of the tarsal-joint to the point of attachment of the lateral extensor to the long extensor; the mucous bursa under the inner branch of the tibialis anticus is roundish in form, the inner wall covers the medial surface of the cuneiform bones and pyramidal bone, the outer wall surrounds

the branch of insertion (spavin-operation); the tendon-sheath of the flexor perforans begins about the width of three fingers above the medial maleolus, passes down the posterior surface of the tibia and the tarsal-joint, and ends just above the point of attachment of the lateral flexor to the tendon of the flexor perforans (inflammations, galls); the tendon-sheath of the lateral flexor arises at the middle of the tibia on the medial side, it is from thirty to thirty-five centimeters in length, passes down the medial surface of the tarsal-joint to the pyramidal bone and terminates at the point where this tendon is attached to the perforans; the tendon-sheath beneath the tendon of the perforatus lies between the cap-like expansion of the latter and the calcaneum, it terminates at the middle of the calcaneum (curb).

I DISEASES OF TENDON

1. INFLAMMATION OF TENDONS. TENDINITIS. TENONITIS.

CAUSES.—Inflammations of tendons occur most frequently in horses; they are caused by strains, overextensions, and partial ruptures of the tendons as a result of overexertion in race-horses, trotters, and heavy draft-horses. Direct contusions of tendons from blows are uncommon. In most cases tendinitis is primarily traumatic in character; as it is not accompanied by an injury to the skin, it is not under the influence of bacteria and is, therefore, aseptic. It has its analogues in the similar traumatic and aseptic bone-fissures, the processes of healing are similar. The following conditions predispose to tendinitis: abnormal positions, especially too long and too weak fetlocks; low heels and long toes; imperfectly developed tendons; deranged nourishment of the tendons as a result of some previous disease, or standing for a long time.

In other cases the inflammatory process proceeds from neighboring tissues to the tendons. Primary inflammation of the tendon-sheaths (contagious pleuropneumonia) often results in a secondary tendinitis. In a similar manner phlegmonous inflammations of the tendon-sheaths from phlegmon of the fatty frog may lead to tendinitis, it may also occur during the process of bursitis podotrochlearis and sesamoid lameness (suppurative and necrotic ten-

dinitis). Tendinitis resulting from inflammation of the tendon-sheaths, when the latter is secondary to infectious diseases (contagious pleuropneumonia), is erroneously termed metastatic tendinitis.

Filaria cincinnata (spiroptera reticulata) is rarely the cause of tendinitis. It is seen in the suspensory ligaments of Russian and Italian horses, and occasionally results in inflammation and lameness, as well as in fibroma-like new-formations (see page 183),

PATHOLOGY.—In recent traumatic tendon-inflammations one first finds a partial fascicular rupture of the tendon-fibers with a trivial extravasation of blood, or a sanguino-serous infiltration of the interfascicular connective tissue. The inflammatory reaction which soon follows is characterized by hyperemia, bloody infiltration, and new-formation of blood-vessels and connective tissue (tendinitis fibrosa). Granulation tissue is formed from the following structures: the paratendineum, the adjacent tendon-sheaths, the interfascicular connective tissue (epitendineum), in part, also from the genuine tendon-cells of the ruptured tendon-fibers. The voluminous, vascular, semi-solid granulation tissue undergoes a partial atrophy of the tendon-fibers; the soft embryonic tissue is transformed into hard, crepitating, nodular connective tissue, which is partly cartilaginous and osseous and which forms a typical tendon-cicatrix (tendon-callus, schlerosis tendinum). At the same time there may occur a contraction, and adhesion of the tendon to the adjacent structures. Necrosis may readily follow suppurative inflammation of tendons.

SYMPTOMS.—Tendinitis occurs principally in the flexor tendons (perforatus, perforans, and suspensory ligament); it is much more frequent in the anterior limbs. In horses it is characterized by lameness, which develops suddenly, or gradually increases in severity, volar flexion is pronounced. There is pain on palpation, increase of local temperature, and in the early stages a semi-solid swelling on that part of the tendon involved, the skin is moveable on the surface. Later there is an increase in the

consistency of the swollen tendon. If resolution does not take place in the swelling, there remains, after the inflammatory symptoms have disappeared, a firm, hard, tendon-nodule or a diffuse thickening of the tendon. The lameness gradually disappears, it may, however, become chronic. When a tendon has once been diseased it is predisposed to relapse; this is especially true of race-horses, saddle-horses, and heavy draft-horses. Severe inflammations finally lead to adhesion between the tendon and the surrounding structures, as well as to the formation of a tendon-contracture (tendon stilt-foot).

TREATMENT.—In addition to complete rest, very recent tendinitis characterized by severe pain and pronounced swelling can be treated with a cold compress, cold baths, or permanent irrigation. In general it is better to immediately employ moist heat in the form of a Priesnitz compress. Massage, and pressure bandage (silicate-of-potash bandage) are occasionally indicated. The methods employed are for the following object: resorption of the hemorrhagic extravasate and to support the natural process of healing, that is, the reactive, aseptic, inflammatory new-formation. It is also important to regulate the shoeing. The toe-calk is removed and excessive length of toe is shortened, this removes strain from the flexor tendons and is of special importance in inflammation of the flexor perforans, the heels may be raised by adding heel-calks.

If the methods described are not followed by healing or improvement after three or four weeks, especially when combined with methodical massage, counter-irritants are indicated. The variety and form of the remedy employed is non-essential, the manner of application of the blistering ointment or plaster is, however, of great importance. After having thoroughly tested the following method of application, which I learned in the Imperial Stables in Vienna, I can highly recommend it: The hair is clipped previous to the application, the skin is also thoroughly washed and disinfected, then apply biniodid of mercury ointment (1:4–5), this is rubbed in thoroughly for fifteen minutes, covered with an ordi-

nary bandage over absorbent cotton, and allowed to remain in position for two weeks. After twenty-four hours the bandage becomes moistened with an extensive exudate which soon dries; the horse's head is tied up for the first few days.

By employing the method described the application of the cautery for chronic tendinitis becomes unnecessary, the cautery may be employed in the form of line-firing. The action of the cautery is like that of blisters; it causes an artificial acute inflammation of the skin and the subcutaneous parts; the blood-vessels are dilated; the white blood-corpuscles pass out of the blood-stream and become phagocytic; the solid masses of exudate are liquefied (peptonized) and resorbed (histolysis), this is due to the formation of ferments from the degenerating white blood-corpuscles.

If hard, painless, nodular thickenings remain in the tendon after the course of a chronic inflammation they cannot be removed any more than other cicatricial formations. Tenotomy may be successfully employed to counteract retraction of the tendon.

The suppurative and necrotic forms of tendinitis must be treated with incision, antiseptic irrigation, and eventually with resection.

STATISTICS OF TENDINITIS.—Tendinitis is the most frequent form of disease of the tendons, it is one of the most frequent surgical affections in the horse. In the years 1886–1895, 36,230 horses were treated in the Prussian Army for inflammation of the tendons and tendon-sheaths. The affection most often involved both the perforans and the perforatus of one limb (70 per cent); then followed the suspensory ligament with 20 per cent. The right anterior limb was most often affected (43 per cent), then followed the left anterior limb (36 per cent) (Bartke).—Inflammation of the tendons is far less common in dogs. Among 70,000 diseased dogs (1886–1895) I have observed only twenty-three cases of tendinitis; the achilles tendon was most frequently affected.

2. TENDON-RUPTURE.

CAUSES.—Incomplete tendon-rupture (partial, fibrillar, fascicular) was described under inflammation of tendons.

Complete (total) tendon-rupture forms another, independent, affection. In contrast to open wounds and incisions of tendons (tendon-wounds), ruptures are usually subcutaneous. The causes are usually external and, like traumatic tendinitis, are ordinarily due to overexertion and overstretching. They are less frequently caused by contusions. As in tendinitis, internal predisposing factors are common (so-called spontaneous tendon-ruptures); these may be due to suppurative inflammation, necrosis, previous infectious diseases (contagious pleuropneumonia, petechial fever), and other derangements in the nourishment (osteomalacia, neurotomy) which cause a loss of resistance. The following conditions especially predispose to tendon-rupture: suppurative tendovaginitis at the fetlock- and tarsal-joints, phlegmon of the fatty frog (nail pricks), and bursitis podotrochlearis. It is especially liable to occur as a result of prolonged standing on three limbs, the well foot becomes affected with painful pressure laminitis, so that the horse is obliged to again bear weight on the diseased foot. In many cases it is not possible to determine the cause of tendon-rupture (simultaneous rupture in several limbs).

Occurrence.—In horses the following tendons are most often ruptured: flexor metatarsi, flexor perforans, flexor perforatus, and suspensory ligament, in cattle and dogs the achilles tendon and flexor metatarsi are most often involved. In general, total rupture of the tendon is less common than other tendinous affections. For example, in the Prussian Army in the years 1889–1895, thirty thousand horses were affected with inflammation of the tendons and tendon-sheaths; during the same time there were about three hundred cases of tendon-rupture. One case of total tendon-rupture occurs to a hundred of tendinitis and tendovaginitis. As a rule only one tendon is ruptured; in race-horses and in spontaneous ruptures one finds, however, two or three, and even all four limbs simultaneously involved. For the process of healing see page 71.

Symptoms.—The symptoms of tendon-rupture are variable, they depend on the tendon affected.

a) Rupture of the flexor metatarsi occurs in

horses, occasionally in cattle, after over-stretching of the tendon from excessive extension of the tarsal-joint (kicks, slips). It is characterized by a dangling movement of the lower part of the hind limb which comes on suddenly, and a peculiar lameness in which the tarsal-joint is abnormally extended. Loss of resistance in the flexor metatarsi is easily recognized when the limb is raised in a position for shoeing, carrying the limb backwards results in tripping, at the same time the achilles tendon appears relaxed and lies in folds. Apparently the prognosis is favorable, healing without treatment usually takes place in one or two months.

b) Rupture of the flexor perforans and suspensory ligament is observed as follows: on the anterior limbs of race-horses, as well as during the course of a chronic inflammation of the pedal-joint, as a result of phlegmonous processes in the tendon-sheaths and the fatty frog. It is characterized by a lameness which develops rapidly with abnormal dorsal flexion of the fetlock-joint; on palpation one may locate a depression in the tendon at the point of rupture. In rupture of the flexor perforans the toe is raised. Ruptures of the flexor perforans and suspensory ligament in the region of the metacarpus usually require two or three months to heal; ruptures which result from necrosis are, however, nearly always incurable. Treatment consists in the application of a plaster-of-Paris bandage.

c) Rupture of the achilles tendon is frequently observed in cattle. It is due to abnormal flexion of the tarsal-joint and excessive stretching of the tendon by means of falls, slips, and jumps, or to severe contraction of the gastrochnemius during extension of the joint. It is characterized by a severe lameness which develops suddenly, excessive flexion of the lower part of the limb, knuckling, and inability to support weight; the achilles tendon is thereby relaxed so that a space may be recognized at the point of rupture. In dogs the prognosis is relatively good (plaster-of-Paris bandage, tendon-sutures), in cattle and horses it is unfavorable (slings). Those cases in which the tendon

pulls away the periosteum and particles of bone from the point of the os calcis are usually incurable.

TENDON-LUXATION. This is occasionally observed in the horse at the expansion of the perforatus where it passes over the os calcis. The dislocation may be either to the external or the internal side. The gliding movements of the dislocated tendon may be seen at the os calcis with every extension. At the same time one observes local swelling and an uncertain stumbling gait. The prognosis is grave, as a rule the luxation is incurable.

3. NECROSIS OF TENDONS.

CAUSES.—Necrosis of tendons is due to a previous suppurative tendinitis, which usually results from extension of phlegmonous processes from adjacent structures to the tendons. As the genuine tendon-tissue is not a vascular structure necrosis may easily occur and extend very rapidly. Necrosis is most frequently observed in the perforans tendon at the navicular bone, due to phlegmon of the fatty frog resulting from nail-punctures. The suppurative process in the frog extends to the bursa podotrochlearis, or, in perforating wounds, it may originate in this bursa and develop into a suppurative bursitis enveloping the perforans tendon in a sac of pus, which results in its rapid necrosis. Necrosis of the suspensory ligament of the bulbs and the navicular bone, as well as the ligament which passes from the lateral cartilage to the first phalanx often results from a suppurative stone-bruise in the angle of the sole. As these ligaments unite the perforans tendon to the fatty frog, and the bulbs to the lateral cartilage, they frequently convey the necrotic inflammation from one of these structures to the other. (Com.: Pfeiffer, Monatshefte für praktische Tierheilkunde. 1897).

SYMPTOMS.—The necrosed particles of tendon present a green, greenish-yellow, or yellow appearance. They appear to slough away rapidly from the sound tendon, so that the smooth, soft, relaxed, greenish-colored membranous structures may be removed from the cavity. Experience has demonstrated that tendon-necrosis may seemingly develop

very rapidly. I have seen diffuse, green necrosis of the flexor tendon develop within a week after the nail-puncture. The other symptoms of necrosis of the flexor perforans are like those of phlegmon of the fatty frog and suppurative bursitis; namely, severe supporting-leg lameness in which the diseased foot bears either little or no weight, pronounced volar flexion, marked swelling in the frog and cleft between the balls, pronounced pain on dorsal flexion of the hoof, as well as a general febrile condition.

TREATMENT.—Treatment of tendon-necrosis is entirely operative. It consists in a free exposure of the tendon and removal of the necrotic particles. When a nail-puncture is followed by the previously described symptoms an early operation renders the prognosis more favorable. The frequency of incurable tendon-necrosis following nail-punctures is largely referable to delay in the operative treatment. The operation may be performed in various ways. I employ the following technique: removal of the frog and fatty frog as far as the tendon by means of a three-cornered incision; cut out that portion of the perforans tendon which lies between the superior border of the navicular bone and its pedal attachment; carefully curette the walls of the bursa, especially that which covers the navicular bone, and remove all necrotic particles that may be attached to it; thoroughly irrigate the funnel-shaped operative wound, and provide drainage by means of an incision in the vicinity of the bulbs; pack with a loose tampon of iodoform gauze, and bandage the entire hoof. When this operation is employed early and the entire terminal portion of the necrotic tendon removed, healing usually occurs in one to two months if the pedal-joint is not involved.

II. DISEASES OF TENDON SHEATHS.

I. INFLAMMATION OF THE TENDON-SHEATHS.

TENDOVAGINITIS.

FORMS.—Inflammation of the tendon-sheaths (tendovaginitis, tendosynovitis, tendinous bursitis, tenalgia) occurs, similar to inflammation of the joints, in various forms. One distinguishes here, also, traumatic (non-bacterial, non-infectious, aseptic), infectious (septic, bacterial), and rheumatic inflammation of the tendon-sheaths; one further distinguishes a primary and a secondary form (symptomatic, metastatic), acute and chronic, tubercular, etc. The various anatomical characteristics of tendovaginitis are of importance. The tendon-sheaths are covered on their inner surfaces with a layer of endothelium which is identical in structure with that lining the synovial membranes of joints, they are also covered with a serous membrane analogous to the pleura and peritoneum. One distinguishes here, then, the following types of tendovaginitis: serous, serofibrinous, fibrinous (croupous, catarrhal, crepitating), suppurative, ichorous, and chronic fibrous. From a practical surgical standpoint it is important to distinguish between the following: acute serous and acute suppurative, as well as tuberculous.

SEROUS TENDOVAGINITIS.—The causes are to be found, either in external mechanical influences (overexertions, contusions), or in internal infectious diseases (contagious pleuropneumonia, septicemia, articular rheumatism, contagious abortion), or cold (rheumatism of the tendon-sheaths). Primary, traumatic tendovaginitis usually affects only one tendon-sheath; the secondary, symptomatic or metastatic inflammations, usually attack several sheaths at the same time.

The symptoms consist in lameness, high temperature, more or less pain, and a soft, either fluctuating (T. serosa) or crepitating (T. serofibrinosa) swelling in the vicinity of the diseased tendon-sheath. If the exudate is not resorbed there develops, either a chronic hydrops

(tendon-sheath gall), or a chronic connective-tissue new-formation with pronounced thickening and schlerosis of the walls (tendovaginitis chronica fibrosa, indurated tendon-sheath galls). In general the course of simple traumatic forms of tendovaginitis is more favorable than the symptomatic; this is especially true of inflammations of sheaths that occur during the course of contagious pleuropneumonia, which are often chronic and remittent in character. Tendovaginitis of the extensor tendons is more favorable than that of the flexors.

The treatment of serous or serofibrinous tendovaginitis consists in the application of moist warmth in the form of Priesnitz compress, as well as massage, further, in the application of a pressure bandage and absolute rest for the animal. Cold, operative treatment, and firing are contra-indicated. When the resorption is delayed and there is a tendency for the process to become chronic, a stimulating application or iodine may be applied.

SUPPURATIVE TENDOVAGINITIS.—This follows open injuries to the tendon-sheaths; it is the result of the entrance of pus-bacteria from without (punctured wounds at the tarsal-joint); it may also be due to the extension of a suppurative phlegmonous process from neighboring structures to the tendon-sheaths (fatty frog); finally, it may have a hematogenous origin in pyemia and strangles.

It is characterized by the following symptoms: a phlegmonous swelling which is very extensive, spreads rapidly, is painful, and is occasionally accompanied by abscess formation. The animal is very lame and often has a high fever. It frequently leads to necrosis and rupture of tendons; to opening of neighboring joints with a subsequent ichorous and suppurative arthritis, especially in the knee-joint (the tendon-sheath of the extensor pedis communicates with the joint-capsule), the tarsal-joint, the fetlock-joint, and the pedal-joint; as well as to septic and pyemic general infection. Occasionally the course is very chronic, several months; the

condition is alternately improved and aggravated for a period of several weeks, relapses are common after the disease has apparently been cured.

Treatment consists in the application of antiseptics. In the early stages one opposes the inflammatory processes by means of antiseptic bandages, baths, and applications (iodoform gauze, camphor ointment, spirits-of-camphor bandage, grey mercurial ointment). This method of treatment, however, must not be continued too long. When it is once demonstrated that there is pus in the tendon-sheath or that the tendon is affected with necrosis, an operation must be performed immediately. This consists in incision, antiseptic irrigation, drainage, resection of the necrotic particles of tendon, and the application of an antiseptic tampon covered with an aseptic bandage. In such cases one does not hesitate to open the sheaths of flexor tendons of the horse. The only rational method of treatment consists in an early free incision and a thorough disinfection of the suppurative tendon-sheath, with removal of the pus and necrotic particles of tissue.

Tubercular Tendovaginitis. According to Hess and Guillebeau this is very common in cattle, it is partly a primary affection, partly secondary to generalized tuberculosis. The tendon-sheath of the extensor metacarpi (M. extensor carpi radialis) on the anterior surface of the carpus is most frequently affected, it may be unilateral or bilateral. Along the course of the named tendon-sheath, occasionally along the entire length of the forearm, there exists a diffuse, hot, firm, painful swelling; it may be as large as a man's arm, at times crepitation is present (tendovaginitis fibrinosa). It is characterized by severe lameness, rapid muscular atrophy at the shoulder, and general emaciation. The animal is usually slaughtered as the condition is seldom curable; the tendon-sheath presents marked thickenings, is hyperemic and covered with fibrin, occasionally it contains numerous corpora oryzoidea (hygroma proliferum). Inoculation of guinea-pigs with the exudate produces tuberculosis.

A similar tubercular tendovaginitis occurs in cattle in the superior tendon sheath of the long extensor of the toe (M. extensor digitorum pedis longus); occasionally the disease is simultaneous with that of tuberculosis of the knee-joint (communication).

2. TENDON-SHEATH GALLS. HYDROPS OR HYGROMA OF THE TENDON-SHEATHS.

CAUSES.—A tendon-sheath gall is a condition characterized by the accumulation of a serous fluid in the tendon-sheaths, the walls of the sheath are dilated and are usually thickened, pain and other inflammatory symptoms are absent, it is termed a chronic hydrops or hygroma of the tendon-sheaths. It usually develops from a chronic, repeated, serous tendovaginitis resulting from severe exertions, it is, therefore, more common in old horses than in young. The inflammatory irritant is found in the mechanical rubbing of the tendon on the walls of the tendon-sheath; the process is aseptic; that is, it develops without the influence of bacteria. Tendon-sheath galls as a result of contagious pleuropneumonia are less frequent (among 1400 horses affected with pleuropneumonia in the Prussian Army in 1895 only five cases were observed).

OCCURRENCE.—Hygromata of the tendon-sheaths are most often observed in horses and draft-oxen. They are usually classified as hygromata of the flexor tendon-sheaths and hygromata of the extensor tendon-sheaths; the former, because of their size, frequency, and difficulty in healing, are more important than the latter.

a) The most important flexor tendon-sheath hygromata in the horse are on the anterior limbs. The flexor tendon-sheath hygromata at the posterior surface of the carpus (the common tendon-sheath of the flexor perforatus and perforans at the posterior border of the carpal-joint, the hygroma originates about ten centimeters above the joint and forms a long swelling which

terminates at the second third of the metacarpus). The flexor tendon-sheath hygromata at the posterior surface of the fetlock, or windgalls (inferior tendon-sheath of the perforatus and perforans, the hygroma forms two long swellings placed at the sides of the tendon of the flexor perforans, behind the metacarpus and above the fetlock-joint). On the posterior limbs, in addition to those mentioned above, which are frequently indurated in the region of the fetlock; there exist hygromata of the flexor tendons in the region of the tarsal-joint (tendon-sheath of the flexor perforans on the postero-internal surface of the tarsal-joint, swelling as large as a child's head on the inner surface, as large as a hen's egg on the posterior surface—curb). Also at the summit of the os calcis (tendon-sheath of the flexor perforatus where it passes over the achilles tendon, it originates twenty centimeters above the summit of the os calcis and forms two long swellings on the inner and outer sides of the achilles tendon, it terminates just above the summit of the os calcis).

b) The most important extensor tendon hygromata of the anterior limbs are, first, those on the anterior surface of the carpal-joint, four so-called carpal tendon-sheath galls. They are arranged as follows from the lateral to the medial surface: 1. Hygroma of the sheath of the extensor suffraginis (M. extensor digiti minimi), a swelling about the size of a goose-egg which begins at the side and above the carpal-joint; 2, distention of the tendon-sheath of the extensor pedis (M. extensor digitorum communis), a swelling that extends from the lower end of the radius over the anterior surface of the carpal-joint, to the upper end of the metacarpus; 3, hygroma of the sheath of the extensor metacarpi (M. extensor carpi radialis) in the middle of the anterior surface; 4, distension of the sheath of the oblique extensor of the carpus (M. abductor pollicus longus), a swelling which passes obliquely downwards and inwards from the supero-external region of the carpus. On the anterior limbs there also occur hygromata of the extensor tendons at the fetlock (mucous

bursa, or tendon-sheath of the long extensor of the toe on the anterior surface immediately over the fetlock-joint ; swelling the size of a goose-egg). On the posterior limbs, in addition to those already mentioned around the extensors of the fetlock, the sheath of the peroneus tendon at the tarsus may also become distended. It forms a hydrops about the size of a walnut on the infero-lateral surface of the tarsal-joint. Finally, although uncommon and seldom large, there occurs an extensor tendon-sheath hygroma on the anterior surface of the tarsal-joint, that is, a tendon-sheath hygroma of the extensor pedis in the middle of the anterior surface of the tarsal-joint.

The walls of these hygromata occasionally undergo pronounced thickening, this is especially true of those on the hind limbs (tendovaginitis chronica fibrosa). Corpora oryzoidea are occasionally observed within the distension (hygroma proliferum).

TREATMENT.—Hygromata of the tendon-sheaths are usually incurable. Ordinarily they are not accompanied by lameness and are of little importance (blemishes). In cheap horses their removal should not be considered. Operative treatment, on the other hand, which is the only method whereby results may be obtained, is not without danger because of the difficulty of applying an aseptic bandage. For this reason treatment is not usually adopted.

When it is decided to employ operative treatment for tendon-sheath hygromata, the only rational method is to make free incisions, irrigate with antiseptics, curette or extirpate the thick, fibrous wall, provide drainage for the tendon-sheath and apply an aseptic bandage. The object of the operation is to obliterate the tendon-sheath by producing adhesions between the walls of the sheath, and healing per prima of the incised wound. The danger lies in the difficulty of obtaining asepsis ; infection may lead to suppurative and ichorous tendovaginitis with a consecutive septicemia and pyemia. However, the operation has been successfully performed several times. Puncture of the hygroma with a subsequent injection of an aqueous

solutiou of iodid of potash (1:100–200) is a safer operation, but the results are less certain. Regardless of a few successful cases, puncture with the cautery cannot be regarded as a safe operation. In chronic hygromata ordinary point and line-firing, as well as applications of blistering ointments or plasters, produce no results.

III. DISEASES OF MUCOUS BURSAE.

1. INFLAMMATION OF MUCOUS BURSAE. BURSITIS.

FORMS.—Diseases of the mucous bursæ may be classified like those of the tendon-sheaths and joints, namely, serous, fibrinous, suppurative and hemorrhagic. They may be further designated as traumatic and infectious, acute and chronic, as well as tuberculous and botryomycotic. According to the seat of the mucous bursa, one further speaks of a bursitis podotrochlearis, intertubercularis, trocanterica, prepatellaris, olecrani, calcanei, and infraspinati. It is of special practical importance to distinguish between an acute serous or sero-fibrinous, and an acute suppurative bursitis.

SEROUS BURSITIS.—The causes of acute serous inflammations (acute hygromata) of the mucous bursæ are usually traumatic. They consist in contusion of the bursa by means of pressure, blows, or kicks, with a subsequent extravasate of blood (bursal hematoma) and a circumscribed inflammation. For example, bursitis olecrani in the horse is due to pressure on the elbow from the heel-calks when the animal lies with the limbs folded under the body (shoe-boil). Bursitis calcanei is due to contusions of the bursa over the os calcis, due to kicking. It has not yet been clearly demonstrated whether metastatic bursitis occurs, as in inflammation of the tendon-sheaths. It is claimed that bursitis podotrochlearis may have a metastatic origin during the course of contagious pleuropneumonia, and that supra-atloid bursitis may result in the same way from strangles (so-called poll-evil).

The symptoms of traumatic bursitis are as follows: swelling which usually develops rapidly (over night), local pain and heat; the consistency of the swelling is variable (semi-solid, fluctuating, crepitating). The contused skin may be partially involved. If resorption does not occur during the course of three or four weeks, there develops a chronic, hyperplastic inflammatory process in the walls of the bursa (chronic hygroma of the bursa).

Treatment of acute serous bursitis consists in massage, Priesnitz compress, application of iodoform-collodion, as well as thoroughly applied ointments of iodoform, camphor, or mercury. Incision is contraindicated. It leads to the danger of a suppurative bursitis as an occlusive bandage is difficult to apply.

SUPPURATIVE BURSITIS.—This is observed in contusions that are accompanied by an injury to the skin and combined with an opening into the bursa; it also results from incisions in serous bursitis. It is characterized by an extensive phlegmonous swelling, as well as a purulent discharge. It often responds very slowly to treatment which consists in antiseptic irrigation, and drainage, as well as operative extirpation of the infiltrated purulent bursa.

TUBERCULAR BURSITIS.—The subcutaneous bursa on the anterior surface of the carpus in cattle is occasionally the seat of a tuberculous inflammation (bursitis fibrinosa). The mucous bursa is transformed into a sac as large as the head of a child; from this a form of carpal tumor, a tuberculous hygroma, may develop (Hess, Guillebeau).

BURSITIS PODOTROCHLEARIS.—This is a chronic inflammation of the tendon-sheath of the flexor perforans in the vicinity of the navicular bone, and just above the attachment of the tendon to the os pedis. It is also known as podotrochlitis,[1] inflammation of the pulley of the foot, chronic lameness of the pedal-joint, or navicular disease. It is especially common in narrow anterior feet of high-spirited horses. The bursa just beneath the navicular bone is exposed to continual strain and contusion from the descent of the bone; this leads to a bursitis

[1]The term "podotrochlitis" employed by Brauell and extensively used since that time is a false expression; it should be called podotrochiliitis. "Podotrochlitis" is a better sounding term (Cf. bursa podotrochlearis).

which develops very slowly with symptons of a chronic arthritis deformans (ulceration and erosion of the cartilage of the inferior surface of the navicular bone, with granular and rarefying ostitis and even fracture of the navicular bone, thickening of the bursa, fibrillation and laceration of the perforans tendon). The disease results in a chronic, usually incurable lameness with contraction of the hoof. As a rule neurectomy is the only method of overcoming the lameness.— There is also an acute suppurative bursitis podotrochlearis due to nail punctures.

2. HYGROMATA OF MUCOUS BURSAE (CHRONIC HYDROPS).

OCCURRENCE.—Hygromata of mucous bursæ usually develop from a chronic bursitis through the continual influence of traumatic injuries; for example, the formation of so-called tumors of the elbow in the horse from lying on a hard surface with the anterior limbs folded under the body, or from contusions of the bursa olecrani when the animal is rising, or the so-called carpal tumors in cattle (contusion of the bursa precarpalis when the animal is rising or lying down). In cattle, a few hygromata are of tubercular origin, especially on the carpus. Tumor-like processes (cysts) appear to be typical of many bursal hygromata. Like the fibrous hygromata of the tendon-sheaths, chronic fibrous bursitis of the mucous membrane may result in thickening and induration, even calcification of the walls (capsule formation), as well as the production of corpora oryzoidea on the inner surface (hygroma proliferum, ganglion crepitans). The neighboring connective tissue also, is involved in the formation of the capsule in the form of a chronic peribursitis. The following are the most important bursal hygromata:

a) Hygroma of the bursa olecrani, so-called shoeboil, forms a circumscribed, round or oval swelling at the olecranon process. In the horse it is the size of a fist to that of one's head; in dogs from that of a hen's egg to that of an apple. In contrast to acute bursitis, it is painless, usually of a firm, hard consistency, and the skin is more or less moveable on the surface. It frequently occurs on both elbows in horses and dogs without causing lameness. In well developed cases it may be considered, not a bursitis, but a product of bursitis.

b) Hygroma of the bursa calcanei, so-called capped-hock, forms a painless, circumscribed, roundish swelling at the seat of the subcutaneous bursa over the tuberosity of the os calcis. It is about the size of an apple, elastic, and is not usually accompanied by lameness. This should be differentiated from other pathological changes in the same region that are also included under the term capped-hock; namely, inflammation and hygroma of the tendon-sheath of the flexor perforatus (cap-like expansion), contused swellings of the skin and subcutem, as well as osteophytic formation on the calcaneum.

c) Hygromata of the subcutaneous bursae over the tuberosities of the ischia, and over the occipital bone are especially common in puppies in the form of painless, circumscribed enlargements from the size of a dove's egg to that of a goose-egg; they are firm and smooth, and the skin is moveable on the surface. In cattle, also, one frequently observes hygromata at the tuberosities of the ischia, occasionally they become very large (size of a head). In horses, hygromata of the same size are occasionally observed on both sides of the withers.

d) In cattle there is frequently observed a subcutaneous hygroma on the anterior surface of the carpus (bursa precarpalis). It is in the form of a firm sac and may reach the size of a man's head (carpal tumor), it is usually traumatic (rising) seldom tuberculous in origin. This form is not common in horses.

TREATMENT.—Treatment, like that of hygromata of the tendon-sheaths, is seldom indicated in bursal hygromata as they rarely cause lameness or other functional derangements. Operative treatment of the so-called capped-hock is not entirely free from danger, especially when it is in the form of a hygroma of the subtendinous bursa of the flexor perforatus. In all well-developed bursal hygromata the application of blistering ointments and plasters, as well as the use of the cautery is of little influence. Mere puncture is rarely followed with favorable results. Better results, especially in the

treatment of shoe-boils, appear to have been attained by means of puncture, and injection of tincture of iodine, with a subsequent incision in the skin and removal of the necrotic sac (Kallmann); this method has also been employed for carpal cysts in cattle (Zehl). If the hygroma is entirely detached, it only requires operative removal, that is, complete extirpation of the cyst (not mere incision) with the knife. The operation, especially in capped-hocks and shoe-boils, usually requires a long period of after treatment. Continual movement and inability to apply an occlusive bandage prolong the process of wound healing. In the treatment of capped-hock the rapidity of healing is increased under the influence of a Bayer's tension-suture, in certain cases it may heal by first intention. Operative treatment is frequently followed by the return of the hygroma as the cause is not removed. Small hygromata may be treated, as in man, by subcutaneous rupture. The long-employed ligature is applicable only to pedunculated hygromata. The application of counter-irritants cannot be recommended. Whether the recently employed injection of pure cultures of staphylococcus pyogenes aureus with subsequent incision of the artificially developed abscess is of practical importance, remains to be demonstrated.

HYDROCELE.—This term indicates a chronic hydrops of the vaginal sheath (processus vaginalis) in which the serous fluid either lies free in the cavity of the fibrous portion of the tunica vaginalis (hydrops ascites), or is found as a circumscribed swelling between the duplicatures of the tunica propria (hydrocele of the spermatic cord). The first form is common in stallions and is occasionally observed during the castration of these animals; it is the product of a serous periorchitis. The second form, on the other hand, while common in man, is seldom seen in animals. Treatment, when one wishes to avoid castration, consists in the extirpation of the tunica propria. Disinfect, make a free incision in the tunica vaginalis and expose the spermatic cord, suture and apply an aseptic bandage.

DISEASES OF MUSCLES, FASCIAE AND NERVES.

I. DISEASES OF MUSCLES.

PRELIMINARY REMARKS ON ANATOMY.

MUSCLES.—Diseases of muscles, especially inflammations of these tissues, are confined, partly to the muscle-fibers, partly to the intra- and intermuscular connective tissue, the perimysium internum and externum, as well as the fasciae and the subfascial spaces. The fasciae play an important part in the surgery of muscles. As the fasciæ have not been given sufficient appreciation in many anatomical text-books, the following description according to Eichbaum will be briefly considered: "(Die Faszien des Pferdes." Berliner Archiv. 1888 und 1889).

FASCIÆ.—Fascia or muscle-ligament is considered a form of aponeurosis. This firm connective tissue membrane is interwoven with elastic fibers. Its function is to enclose or separate muscles or groups of muscles in a sheath-like manner. It consists largely of connective-tissue fibers with a few blood-vessels and nerves, this accounts for its tendency to necrosis. Interfascicular spaces are located between the fasciæ; phlegmonous processes extend very easily and rapidly within these spaces. The fasciæ support the muscles in their activity by performing the functions of a physiological pump, they favor the circulatory movements of the blood and lymph during contraction and relaxation of the muscles. Ruptures of fasciæ result in the formation of muscle-hernias, and dislocation of muscles (biceps femoris in cattle). On account of their firmness they are not often affected with inflammation; occasionally they form a wall against outward or inward progression of an inflammation. On the other hand, they favor the extension of subfascial phlegmons. The question of the relation of contractures of the fasciæ to the development of stringhalt is still open for accurate scientific demonstration.

I. FASCIÆ OF THE HEAD AND NECK.—1. The superficial fascia of the neck (F. superficialis colli) is in combination with the cutaneous muscle in the horse (aponeurotic portion of this muscle). It forms two lamellæ, and extends from the ventral margin of the neck over the lateral surfaces, terminating on the dorsal margin (cervical ligament). A median septum passes downwards in the median line of the inferior cervical border.

2. The deep fascia of the neck (F. profunda colli) passes over the anterior and lateral surfaces of the trachea, and forms the capsule of the thyroid glands above, as well as the external surface of the guttural pouches. The jugular vein, surrounded by loose connective tissue, lies between the superficial and the deep cervical fascia. At the thoracic inlet this fascia covers the inferior tracheal glands.

3. The fascia propria of the trachea encloses the trachea in the form of a sheath.

4. The nuchal Fascia (F. nuchæ) borders posteriorly the subcutaneous cervical fascia, and is to be considered as a lateral continuation of the cordiform portion of the ligamentum nuchæ. It is located in the region above the shoulder, and is covered with the superficial cervical fascia. In the vicinity of the superior cervical border it is very thick and contains the so-called fatty crest.

5. The fascia of the parotid and masseters (F. parotideo-masseterica) lies between the auricular, parotid, intermaxillary, facial and masseter surfaces. The pharyngeal fascia extends over the external surface of the pharyngeal muscles.

6. Tenon's fascia (Tenon's capsule) originates on the corneal margin of the orbit, passes over the anterior portion of the schlera, and from there to the retractor bulbi, finally enclosing the optic nerve.

II. FASCIÆ OF THE TRUNK AND PELVIS.—1. The superficial fascia (F. superficialis s. subcutanea) lies below the thoracic and abdominal panniculus carnosus, and becomes attached to the linea alba in the median line. Posteriorly it forms the basis of the knee-fold, as well as the superficial layer of the fascia of the prepuce, covers the inguinal ring as well as the pudic glands, and encloses the testicles in the form of the muscular-dartos.

2. The dorsal fascia (dorso-lumbar fascia, F. lumbo-dorsalis) is divided into a superior, superficial layer, which covers the longissimus dorsi muscle, and an inferior, deep layer, which lies between the last rib and the anterior margin of the ilium. Between the superficial fascia (1) and the dorsal fascia there lies an interfascial space filled with loose connective tissue (of surgical importance with reference to fistulous withers and saddle-pressure); similar spaces are located between the layers of the dorsal fascia, as well as between the superficial layer of the dorsal fascia and the longissimus.

3. The yellow abdominal tunic covers the external oblique muscle. A continuation of this goes to form the fascia of the penis, or the supporting ligament of the udder; in combination with the terminal aponeurosis (Poupart's ligament) of the external oblique muscle it forms the inguinal fold and the crural membrane (lamina femoralis).

4. The lumbo-iliac fascia (F. iliaca s. lumbo-iliaca) covers the inferior surface of the iliopsoas in the lumbar region and becomes continuous with the pelvic fascia.

5. The transverse abdominal fascia (F. transversa s. transversalis abdominis) lies between the transverse abdominal muscle and the peritoneum. The tunica vaginalis communis is a continuation of this fascia.

6. The pelvic fascia (F. pelvis) covers over the inner surface of the walls of the pelvic cavity.

7. The perineal fascia (F. perinei) is divided into a superficial layer (F. perinei superficialis), a continuation of the subcutaneous fascia of the hips, and a deep layer (F. perinei propria), a continuation of the fascia of the hip.

III. FASCIÆ OF THE ANTERIOR LIMBS. 1. The superficial fascia (F. superficialis) lies beneath the panniculus carnosus as far as the elbow-joint, it is thin and transparent and extends as far as the fetlock-joint.

2. The scapulo-humeral fascia (F. brachii) lies beneath the preceding on the external surface of the scapulo-humeral region, and consists of a superficial and a deep layer; the first becomes continuous with the superficial layer of the sheath of the biceps brachii.

3. The true or deep fascia of the forearm (F. antibrachii) passes, in the form of a firm band, over all the muscles of the forearm as well as the median surface of the radius. At the carpus it forms the deep carpal sheath (F. carpi profunda), on the volar surface of the carpus it forms the transverse ligament of the carpus, it terminates at the middle of the flexor tendons in the form of a semilunar margin. It forms several intermuscular ligaments between the extensors and flexors of the forearm.

4. The fasciae of the foot (F. plantaris) form broad or small ligaments which hold the tendons in position and strengthen the articular ligaments.

IV. THE FASCIÆ OF THE POSTERIOR LIMBS.—The superficial fascia (F. superficialis) is formed from a continuation of the aponeurosis of the abdominal panniculus; it covers the muscles of the hip, the biceps and semitendinosus, as well as the sartorious, gracillis, and semimembranosus as far as the region of the knee; it terminates at the coronet.

2. The fascia of the hip (F. gluteii) lies beneath the preceding, and is a continuation of the dorsal fascia, it covers the muscles of the hips and buttocks, and becomes continuous with the fascia lata at the femur. Passing downwards it is transformed into a fascia which encloses the muscles of the femur (tensor facia lata, biceps, semitendinosus); passes the tibia, and may be traced as far as the tarsal-joint. It also forms numerous intermuscular septa between the muscles of the hip and the femur.

3. The femoral ligament or broad crural ligament (F. lata) is a continuation of the aponeurosis of the external oblique muscle on the inner surface of the limb, it fuses with a projection of the gluteal fascia on the anterior and posterior margins of the upper part of the limb. It forms a ring for the entire musculature of the femur.

4. The tibial fascia (F. cruris) covers the muscles of the tibia in the form of a very strong aponeurosis, and extends downwards over the tarsal-joint and the metatarsus. It consists of a superficial (continuation of the crural fascia), and a deep layer (formed from the tendon

of the biceps, semimembranosus, semitendinosus and gracillis), as well as the common sheath of the tibial muscles. The last named muscle-sheath encloses the muscles and is in immediate contact with them, it is divided into three parts: 1. The muscle-sheath for the flexor metatarsi, anterior tibial muscle and long extensor of the toe; 2. The tendon-sheath for the flexor perforans and popliteal muscle; 3. The tendon-sheath for the lateral extensor of the toe.

1. INFLAMMATION OF MUSCLES. MYOSITIS.

FORMS.—According to causes, the following forms are recognized: traumatic (contusions), rheumatic (cold, muscular rheumatism), infectious (bacteria), and parasitic myositis (sarcosporidia, trachina). The following specific infectious and parasitic types of myositis are also recognized: actinomycotic, botryomycotic, sarcosporidic, trichinous, tubercular, and glandular myositis. According to the course one distinguishes an acute and a chronic; according to the character of the inflammation, a serous, suppurative, interstitial or fibrous, parenchymatous, and ossifying myositis. Finally, inflammation of muscle may be classified as primary and secondary (symptomatic, metastatic). The latter is observed during the course of pyemia, strangles, tuberculosis, etc. The following are of practical importance:

a) Traumatic myositis.
b) Muscular rheumatism.
c) Parenchymatous myositis.
d) Suppurative myositis.
e) Interstitial myositis.
f) Ossifying myositis.

TRAUMATIC MYOSITIS.—This most often occurs in horses as a result of contusions and exists in the form of an aseptic inflammation, it may also result from overextension, strain, or partial rupture of muscles. It is partly hemorrhagic, partly serous (myositis hemorrhagica and serosa). It is especially observed in the region of the shoulder as a result of blows and collisions. It is a cause of one form of so-called shoulder lameness which is characterized by well

pronounced hanging-leg lameness and dragging of the limb; it is usually due to an inflammation of the lower end of the mastoideo humeralis or the biceps muscle. Local examination reveals a circumscribed area of pain, swelling, as well as increased heat in the part on palpation. In contrast to rheumatic myositis, the area of pain has a definite local boundary, and is not wandering; ordinarily the anamnesis furnishes evidence of the traumatic origin. Traumatic myositis is also observed on transports as a result of improper treatment and narrow stalls, especially in cattle and swine in the following places: muscles of the shoulder, thorax, and gluteal regions. When the animals are slaughtered the following conditions are observed: serous and hemorrhagic, gelatinous infiltration of the internal and external perimysium, softening, discoloration, and degeneration of the muscular bundles, as well as loss of transverse striations, and other degenerative changes in the muscular fibers. Traumatic myositis usually runs an acute course; this is especially observed in those cases of shoulder lameness in the horse due to muscular contusions. In many, resorption is rapid and recovery is complete in a few days. In other cases there is a connective-tissue development between the muscle-fibers at the seat of the contusion as the result of a chronic aseptic inflammation (interstitial myositis; schlerosis of muscles). Treatment consists in rest and massage, as well as in the application of moist warmth in the form of Priesnitz compress.

MUSCULAR RHEUMATISM.—Rheumatic myositis due to cold is most often observed in horses, dogs and cattle. The anatomical changes are as follows: hyperemia, serous and small-celled infiltration of the perimysium internum (polymyositis serosa), softening, discoloration and degeneration of the muscle-fibers (cloudy swelling, and fatty degeneration); multiple hemorrhagic foci are less common (polymyositis hemorrhagica). When the disease runs a chronic course, rheumatic muscular cicatrices form as a result of new formations of connective tissue (interstitial myositis) and atrophy of the genuine muscle substance. The symptoms consist of lameness which develops

suddenly after a previous cooling (rheumatic shoulder lameness, rheumatism of the shoulder, omodynia, rheumatic sacral lameness, lumbago), oblique position of the neck (torticolis), occasionally dyspnea (pleurodynia). Shoulder lameness may be caused by a myositis of the mastoideo humeralis, lameness in the sacral region by myositis of the psoas muscles. These muscles are painful on palpation, this is especially true of the psoas muscles in lumbago of the dog. Hemoglobinuria (lumbago, azoturia) of the horse is considered a rheumatic myositis of the lumbar muscles, in contrast to traumatic myositis the rheumatic form is often wandering and recurrent; it often temporarily disappears entirely when the animal is moved for some time. It also has a much greater tendency to run a chronic course. Treatment consists in the external application of moist warmth, massage and stimulating applications (spirits of camphor), as well as the internal administration of salicylic preparations (horses 100 grams, dogs 2 to 8 grams, of salicylate of soda per day), antifebrin or antipyrin. In very obstinate cases of rheumatic shoulder lameness in the horse one may also employ subcutaneous injections of veratrin (0.05 grams veratrin in 5.0 grams spiritus). Very painful omodynia in the horse, and lumbago in the dog, are often rapidly improved by subcutaneous injections of morphine (0.02-0.05 grams). The combined application of atropin and morphine in shoulder lameness of the horse, on the other hand, is not safe (fatal colic).

Parenchymatous Myositis.—As a result of excessive muscular exertion, and pronounced exhaustion of the musculature of the body, especially from overheating as a result of riding for a long distance, running on the track ("race-track disease"), after standing for a long time in the cars ("shipping-disease" of cattle), after tying horses high in the stall for a long time, after driving cattle long distances, after casting, as well as a result of severe attacks of hemoglobinemia (azoturia), there develops in horses, occasionally also in cattle, an acute, parenchymatous degeneration of muscles, with symptoms of parenchymatous myositis. The following groups of muscles

are most often affected: the dorsal and gluteal muscles, those of the psoas group, the quadriceps and the anconeus. On external examination of these muscles, especially the longissimus dorsi and the glutei, one finds in the early stages, a hard swelling and severe pain on palpation, the back is carried stiffly; occasionally one also observes symptoms of colic, hemoglobinuria, and high fever. According to the degree of extension and localization of the muscular degeneration one further observes, either a general or sacral paralysis (sacral weakness), or a paralysis confined to the extensors of the knee and elbow (falsely so-called crural and radial paralysis); it may be unilateral or bilateral. The macroscopic anatomical changes are as follows: pale, light-grey color of the muscle, occasionally it is colored like the flesh of fish, is abnormally friable, and has a cooked appearance. Intramuscular hemorrhage and rupture are sometimes observed. Microscopically, in addition to the symptoms of secondary inflammation, various forms of muscular degeneration are seen: cloudy swelling (albumenoid), fatty, hyaline or amyloid degeneration. The termination is variable. At times the animal dies suddenly as a result of general paralysis. In other cases degenerative atrophy of the involved muscles may occur, it is partly chronic, partly acute and is characterized by symptoms of paralysis and weakness. Treatment consists in the use of slings, massage, and electricity, as well as subcutaneous injections of caffein and camphor.

Since the year 1896 when I first referred to the parenchymatous form of myositis, which results from overheating, and casting of horses, and called attention to the relation between this and hemoglobinuria, many similar cases have been observed in horses and cattle. A horse that was thrown for neurectomy became very uneasy, on the following day there developed symptoms of hemoglobinemia. The post mortem revealed parenchymatous polymyositis (Preuss. Stat. Militär-Veterinärbericht pro 1900). A horse showed all the symptoms of hemoglobinuria after an operation that lasted an hour and a quarter, during the operation the animal struggled violently (Dages). A horse that was operated showed symptoms of paralysis three days after being cast, hemoglobinuria became evident

on the fourth; post mortem revealed myositis of the muscles of the limbs. A two-and-one-half year old colt was led 90 kilometers [55 miles], after which it stood a half day in the market. It showed general muscular paralysis, acute degenerative bilateral muscular atrophy in the gluteal and femoral regions, as well as hemoglobinuria; it was two months before the animal was able to stand (Warncke). Hemoglobinemia occurred in a cow as a result of overexertion during transportation; post mortem revealed paleness of the musculature and rupture of the right extensor of the patella (Rüegg). Villagio considers "shipping disease" in cattle as a primary parenchymatous myositis due to overexertion.

SUPPURATIVE MYOSITIS.—This occurs in infected muscle-wounds, either in the form of a phlegmonous myositis, or muscular abscess; it leads to suppurative liquefaction and necrosis of the muscle and its fascia, to fistula formation, burrowing of pus, septicemia, and pyemia. In other cases interstitial myositis leads to encapsulation of the suppurative foci. The latter form is especially observed in the so-called shoulder abscess of the horse. It is partly due to infection with streptococcus and staphylococcus pyogenes albus, partly to that of the botryomyces organism; it results in a circumscribed suppurative myositis of the mastoideo humeralis, the infection gaining entrance through superficial contused wounds in the skin assisted by the lymphatic system. In one case observed by Johne the tubercle-bacillus was the cause of a shoulder abscess in the horse. Multiple abscess formation of the muscle (myositis apostematosa multiplex) may have a metastatic origin as a result of the activity of pus-forming bacteria, or it may be caused by the streptococcus of strangles, it is observed during the course of pyemia and strangles. Treatment of suppurative myositis consists in free incision, or extirpation of the encapsuled abscess in shoulder tumors. The treatment of shoulder abscesses by means of parenchymatous injections of concentrated salt solution cannot be recommended (Schmidt); according to Schilling a horse treated by this method died in four days as a result of gangrene and sepsis; Esser has employed it two different times with unsatisfactory results.

INTERSTITIAL MYOSITIS.—Interstitial fibrous myo-

sitis (schlerosis of muscles) is a chronic inflammation of muscles characterized by a new formation of connective tissue, it leads to induration and contracture of the muscles, and may be caused by various inflammatory stimuli. It is observed during the course of chronic muscular rheumatism; after traumatic, suppurative, actinomycotic (wooden-tongue), tubercular, and botryomycotic myosites; in muscular paralysis, and muscular atrophy. In some cases the inflammatory irritant is not recognized. In most cases, however, it originates from the activity of bacteria or parasites. Many cases of so-called rigidity of the os uteri in cattle may be designated as chronic interstitial myositis of the cervix uteri. Palat has described a peculiar case of multiple interstitial myositis in the horse. In an omnibus horse there occurred, without visible cause (encysted muscle parasites?), hard swellings on the throat, shoulder, thorax, and hips, as well as on the buttocks; this was soon followed by a slowly developing general muscular weakness so that it was necessary to destroy the animal. On post mortem examination he found connective-tissue new-formations between the muscle-fibers of the groups named; nodules were scattered through these areas; in character they were fatty, calcified, and cartilaginous. Fibrous myositis is incurable unless actinomycotic in character (incision and iodin for wooden-tongue).

Ossifying Myositis.—Osseous formation during the course of inflammation of muscle has been frequently observed in horses, dogs and swine (Kitt, Cadiot, Constant, Stephenson, and others). The causes are extremely variable. Part of the cases are due to multiple exostosis formation at the seats of muscular attachments, ossification of the muscles is a secondary process. An interesting case of multiple hyperostosis formation in the horse has been described by Constant; it was identical with a form which is occasionally seen in young people, where it is termed myositis ossificans multiplex progressiva. Because of chronic incurable lameness the patient was destroyed. On post mortem it presented the following characteristics: the attachment of

the middle gluteal muscle was ossified, in the belly of the muscle there was located an osseous tumor the size of one's fist, adhesions had taken place between the muscle and the pelvis; the pectineus and adductor longus muscles were also adherent to the pelvis and ossified. The internal obturator muscle formed a bony tumor (osteoma) on the inner margin of the obturator foramen; finally, the ossified muscular attachments projected from the trocanteric fossa in the form of bony stalactites.—In other cases the ossifying myositis assumes the form of a tumor-like process (osteoma) or it may originate from callus formation as a result of fractures. In man ossifying inflammation of the muscles is occasionally observed after continued traumatic influences (exercise of the biceps, rider's bone in the gracillis). Similar changes have been found in the biceps brachii of the horse as a result of bursitis intertubercularis.

Myositis Sarcosporidica.—Inflammation of muscles due to the wandering of sarcosporidia (psorospermia, Miescher's tubules, gregarinae) is especially observed in swine, cattle, sheep, and horses (omnivora and herbivora). These are sicle-shaped spores arranged in capsules, when the capsule ruptures they are transformed into wandering cells which penetrate the adjacent musculature in the form of an inflammatory infiltration. In the shoulder and dorsal muscles of the horse they occasionally lead to the formation of sarcosporidia-swellings as large as one's fist, hard, and white or grey in color. In sheep they lead to the formation of encapsuled sarcosporidia-cysts in the musculature of the esophagus, they reach the size of a pea. As a rule, however, the non-ruptured capsule is harmless, and it is a frequent condition. It is most often found in the muscles in the vicinity of the oral and pharyngeal cavities, as well as those of the esophagus, in the tongue, in the masseter, buccinator, laryngeal, and pharyngeal muscles. Occasionally their presence in muscle leads to interstitial myositis with atrophy and cellular infiltration of the connective tissue of the adjacent muscular fibers. In other cases the flesh of cattle is clear and has an appearance of the flesh of calves, this is due to the presence of large numbers of sarcosporidia. In old horses, as well as buffaloes, sarcosporidia appear to be constantly present, in swine, also, they were found in a fourth of those examined by Perroncito. Among a hundred cases of cachectic sheep examined by Moulé, sarcosporidia were found in ninety-nine. Miescher's tubules are very common in the muscles of herbivorous domestic animals, they seldom cause disease in the

host; only in very rare cases have symptoms been observed which were due to inflammatory changes in the muscle as a result of the presence of large numbers of sarcosporidia. Höflich has described an interesting case of glossitis chronica sarcosporidica in a horse; it was characterized by pronounced thickening of the tongue, deranged prehension of food, as well as emaciation. Dammann and v. Niederhausen observed dyspnea in a sheep and a goat as a result of inflammation of the pharyngeal and laryngeal muscles. Brouwier and Tokarenko observed difficulty in walking and standing, even complete muscular paralysis in steers. Virchow saw paralysis of the posterior extremities in swine. In two swine Brschosniowski observed loss of appetite, continued recumbent position, pain on pressure in the muscle, arched back, irregular movements of the hind parts, hoarse voice and fever (suspected trichinosis); after slaughter the musculature was found to be watery, cloudy, and permeated with numerous sarcosporidia. For further information concerning the literature and development of sarcosporidia compare with symptoms of myositis trichinosa. (Cf: Friedberger and Fröhner, Special Pathology of the Domestic Animals. 1904, 6 Ed., Vol. I.).

2. RUPTURE OF MUSCLES.

CAUSES.—Muscle-rupture occurs most often in horses and cattle, partly as a result of contusion and rupture from without, partly from overstraining and excessive muscular contraction. As in tendon-rupture, in addition to ordinary traumatic causes, so-called spontaneous ruptures may occur as a result of diseased changes in the muscle. In general muscle-ruptures are not common; in the years 1888–1896 about 1800 cases, 200 a year, were treated in the Prussian Army for contusion and rupture of muscles. As a rule the ruptures involved the flexor metatarsi (20 cases per year). In the years 1886–1895 I found only twenty cases of muscle-rupture among 70,000 diseased dogs.

OCCURRENCE.—Muscle-ruptures are most frequently observed in the following places: abdominal muscles (blows and overstretching during the course of pregnancy in cattle, less frequently from casting horses); muscles of the posterior limbs (overstretching from slipping, struggling when fettered, abnormal contraction when kicking); as well as in the cervical, shoulder, and thoracic muscles

(caused in the horse from running against wagon poles). The individual muscles most frequently involved are the tibialis anticus; rectus, obliquus, and transversalis abdominis; the quadriceps femoris; the glutei and gastrochnemii; the biceps femoris and brachii; the mastoideo humeralis, and pectoralis.

SYMPTOMS.—According to the physiological activity of the ruptured muscles one observes various derangements in function in the vicinity of the muscular apparatus, namely, lameness, symptoms of paralysis, and prolapse. At the seat of rupture one can frequently recognize a space or cavity on the edges of which one may palpate the ruptured and afterwards swollen muscle; occasionally there exists a fluctuating swelling at the seat of rupture due to the formation of a hematoma following rupture of blood-vessels. The most important muscle-ruptures present the following symptoms:

a) Rupture of the tibialis anticus muscle results in abnormal extension of the tarsal-joint with severe hanging-leg-lameness, dangling movements of the limb, and relaxation (folds) of the achilles tendon. On account of the muscles being covered with the fascia of the limb and the extensor pedis, there is not usually visible, either depression, hematoma formation, or swelling. The prognosis is not unfavorable; healing occurs in from one to two months.

b) Rupture of the gastrochnemius produces the following symptoms: relaxation of the achilles tendon, and inability to support weight at the knee or tarsal joints, such attempts being followed by excessive flexion. A space is usually present in the course of the gastrochnemius muscle. The prognosis is very unfavorable; healing in horses and cattle is rare.

c) Rupture of the quadriceps femoris is followed by symptoms of paralysis of the quadriceps, namely, inability to support weight at the stifle (sudden flexion).

d) Rupture of the abdominal muscles is occasionally followed by an abdominal rupture (hernia abdominalis), this is especially true of cattle.

e) Rupture of the mastoideo-humeralis results in the following symptoms: hanging-leg-lameness of the involved anterior limb, hematoma formation, occasionally abscess formation at the seat of rupture.

TREATMENT.—Reposition of the ruptured muscle ends by means of the muscle suture is not practical in large domestic animals. Treatment consists in providing rest (slings, high tieing), in certain cases massage may be employed. Healing of the ruptured area occurs through the formation of a cicatrix as the result of an aseptic interstitial myositis; occasionally cicatrization leads to contracture of the muscles and permanent shortening (torticollis after rupture of the mastoideo-humeralis).

LUXATION OF MUSCLES.—This name signifies a change in position (dislocation) of certain muscles. The biceps femoris in cattle is occasionally involved as a result of slipping; the upper insertion of this muscle becomes detached from the trocanter and is displaced backwards; it results in sudden lameness with extension of the entire limb and inability to flex the joints. Treatment is operative (myotomy). It is stated that luxation of the biceps femoris and brachii is occasionally observed in the horse (Feger, Dominik).

3. ATROPHY OF MUSCLES.

CAUSES AND FORMS.—Muscular atrophy is a symptom of various pathological conditions. The following forms are recognized:

a) Simple muscular atrophy consists in diminution in the size and number of muscle-fibers without degenerative changes. It is observed in the form of so-called atrophy of inactivity, it is a constant symptom of chronic lameness, it is most often found in connection with spavins and ringbones in the horse, and during the healing of bone fractures. The forensic importance of muscular atrophy for the determination of the duration of lameness is usually overestimated. Regardless of the fact that very often the relation between a lameness and an existing muscular atrophy is not sufficiently demonstrated, experience has proved that a visible atrophy of the muscles of the gluteal or shoulder regions

may develop much more rapidly than is generally supposed. Atrophy develops more rapidly when the animal is in good condition and very lame. The principles maintained by Gerlach in his standard veterinary medicine (1872) are still in force. According to his work the parenchymatous fluids of the soft tissues may become visibly diminished in a very few days. In very painful cases of lameness the fatty tissue is visibly diminished after eight days; in very fat animals this may result in extensive atrophy of the limbs within two to three weeks. In muscular animals the flesh and cellular tissues have undergone visible atrophy in three weeks. Tendon becomes atrophic after a few months; the bones and hoof become visibly smaller after three to six months.

b) Degenerative muscular atrophy consists in cloudy swelling, fatty, wax-like or hyaline, and amyloid degenerations, as well as disintegration of the muscle-fibers. It develops after inflammation and paralysis of muscles. It is most often observed in the horse as a result of parenchymatous myositis of the longissimus dorsi, the gluteal, the quadriceps, and anconeus muscles in azoturia; it may also occur after overheating and casting. In this manner a very rapid form of atrophy may occur, so that high-grade muscular atrophy may be visible on the back and hips in a few days (even entirely unilateral). It is also observed after paralysis of the suprascapular nerve (atrophy of the spinati muscles), the radial nerve (atrophy of the anconeus), the trigemminus (atrophy of the masseters), as well as the recurrent (atrophy of the left laryngeal muscles; roaring). It is also seen in muscular rheumatism, in diseases of the dorsal marrow, as well as in chronic lead poisoning (atrophy of the laryngeal muscles; roaring).

c) Lipomatous atrophy or pseudo-atrophy (lipomasia) of the muscles consists of an interstitial fat-cell proliferation with displacement of the muscle-fibers.

TREATMENT.—Degenerative atrophy is usually an incur-

able condition. From a prophylactic standpoint, to prevent development, one may employ exercise, massage, volatile applications, and electricity, as well as internal stimuli (strychnine, veratrin, caffein).

HYPERTROPHY OF MUSCLE.—This term signifies a condition opposite to that of muscular atrophy, it is usually the result of increased activity (training). When horses are checked high there also develops a hypertrophy of the sterno-maxillaris, and sterno-thyro-hyoideus muscles as these are especially involved; occasionally they present symptoms of myositis. Sometimes one finds unilateral hypertrophy of the mastoideo-humeralis in normal horses.

II. DISEASES OF FASCIÆ.

I. NECROSIS OF FASCIÆ.

CAUSES.—Necrosis of the fascia is of special importance in the horse; either its presence is unrecognized or its importance is underestimated. It results, either from a suppurative muscle-wound or from intermuscular and subfascial phlegmons. In both cases the fascia easily becomes necrosed because of its non-vascularity. On account of the firm structure of fascia, and because of the deep position and horizontal extension of many fasciæ, spontaneous sloughing and removal of the necrotic part is either very difficult or impossible. Necrotic portions of the fasciæ lead to chronic suppurative processes and fistula formation which can only be removed by operative means, that is, the necrosed tissue must be cut out.

SYMPTOMS.—That class of pus fistulæ described in veterinary surgery under the names fistulous withers, shoulder fistula, fistula of the buttocks, fistula of the fetlock, and coronary fistula are often maintained in the following manner: as a result of suppurative and phlegmonous processes, necrosis of the fascia is caused in the depths of the dorsal, shoulder, and gluteal muscles, as well as in the fascia of the foot; this necrosis maintains a chronic suppurative condition. The necrosis is usually circumscribed; it may, however, become very exten-

sive, for example, a diffuse subfascial phlegmon along the course of the longissimus dorsi may cause septicemia and terminate fatally. I have observed one example of this in a case of fistulous withers in the horse.

TREATMENT.—When necrosis of the fascia is supposed to form the foundation of a fistula, one should not hesitate to expose the dead pieces of fascia by means of extensive, deep, long, and broad incisions, through which all the necrotic portions are removed by means of the scalpel or scissors. In this manner fistulae of the withers, shoulder, and gluteal regions that have been in existence for months may be healed in a few weeks. One had better remove too much than too little from the diseased muscle and fascia, otherwise it will be necessary to repeat the operation. First make long, deep incisions, through which, under certain circumstances, pieces of flesh as large as a pound may be removed, excise the fascia regardless of its extent; by following this method of treatment I have been able to cure many cases of fistula in the horse. The after-treatment consists in preventing stagnation of the wound secretions in the depths of the fascia and muscles. This may be accomplished, either by means of open-wound treatment or drainage; when practical it is best to employ permanent antiseptic irrigation of the operation wound for several days.

2. RUPTURE OF FASCIÆ.

RESULTS.—When the superficial fascia, not the muscle itself, becomes ruptured subcutaneously by means of blows or kicks, the soft muscular structure sometimes projects through the rent in the fascia. The involved area presents a visible, circumscribed swelling. So-called muscle-hernia is caused, especially in the horse, by kicks or pole-thrusts and occurs on the muscles of the limbs or neck. In the horse I have several times observed hernias of the semimembranosus, of the mastoideo-humeralis, and of the anconeus. On palpating such a hernia one feels the sharp firm margin of

the fascia, and a soft area in the center. It is best to allow hernia of the muscle to recover without treatment; when the condition is aseptic and lameness is absent, incision of the skin with subsequent suturing of the torn fasciæ is superfluous.

STRINGHALT.—The term stringhalt signifies a peculiar derangement in the movements (ataxia) of the horse which is characterized by a sudden, jerking, involuntary, excessive flexion of all the joints of the hind limb. The causes have not been satisfactorily explained. An idiopathic form of stringhalt is recognized; by some it is considered a contraction of the tibial fascia, a retraction of the tensor fascia lata, or the tendon of the peroneus; by others, a shortening of the transverse ligaments of the patella; while some refer it to a nervous affection (disease of the spinal cord, peripheral neuritis, reflex neurosis). The treatment, therefore, is extremely divergent (incision of the fasciæ, articular ligaments, tendons, nerves). Symptomatic stringhalt forms one of the symptoms of spavin, ringbone and scratches, as well as various affections of the tarsal and pedal-joints (treads on the coronet, nail-pricks, clefts in the horn); they produce reflex symptoms which may be compared with the twitching movements observed in people suffering from gout.

III. DISEASES OF NERVES.

1. PARALYSIS OF NERVES. PARESIS AND PARALYSIS.

FORMS. Various forms of paralysis of the nerves are recognized according to the grade, origin and extent. First, one recognizes two grades of paralysis, namely, simple weakness, paresis or incomplete paralysis; and complete paralysis. According to the origin the different forms of paralysis are classified as cerebral, spinal, and peripheral, with reference to the seat of the disease in the brain, spinal column, or peripheral nerves. One also differentiates motor and sensory, neurogenic and myogenic paralysis. Finally, with reference to the extent of the paralysis, it is termed monoplegia when only one limb or group of muscles is involved, when one entire side of the animal is affected it is termed hemiplegia; when bilateral, it is termed paraplegia. The division into atonic, spastic, organic, and functional paralysis is of slight importance in veterinary science.

CAUSES.—The causes of paralysis of nerves are extremely variable. Cerebral and spinal paralysis may be due to the following causes: disease of the brain or spinal marrow, traumata, infectious diseases, and poisons; peripheral paralysis results from rupture, laceration, compression and inflammation of the peripheral nerves.

DIFFERENTIAL DIAGNOSIS.—It is easy to differentiate between cerebral, spinal, and peripheral paralysis. Paralysis due to an affection of the brain is usually characterized by monoplegia and hemiplegia. Frequently one of the cranial nerves is involved, and it is often accompanied by derangement of the consciousness. There are several symptoms by which spinal paralysis may be differentiated from cerebral. Ordinarily it results in paraplegia, while the cerebral produces mono- or hemiplegia. This may be explained by the small size of the spinal marrow in comparison with that of the brain; the pathological process usually affects the entire transverse diameter of the organ. For this reason the paralysis is both motor and sensory (anterior and posterior horns). This results in paralysis of all the muscles situated posterior to the diseased area in the spinal cord. Psychic derangements are usually absent in spinal paralysis, the cranial nerves usually remain unaffected, in cerebral paralysis they are usually involved. Simultaneous paralysis of the bladder and rectum indicates a spinal affection. Spinal paralysis usually extends forward from the primary seat, ascending. Finally, trophic derangements in the paralyzed structures (muscular atrophy) are especially characteristic of spinal paralysis. Peripheral paralysis involves only individual muscles or groups of muscles without cerebral or spinal complications. Occasionally it is very difficult to differentiate between neurogenic and myogenic paralysis. That form of parenchymatous myositis of the anconeus and quadriceps group, which is especially frequent in the horse, may possibly be falsely termed radial and crural paralysis.

SYMPTOMS OF PERIPHERAL PARALYSIS.—While cerebral and spinal forms of paralysis produce symptoms of motor and sensory depression of the brain and spinal marrow, disease of

the peripheral nerves results in symptoms which vary according to the function of the nerve involved. In veterinary medicine the most important forms of peripheral paralysis result in the following symptoms:

a) Facial paralysis results in a unilateral paralysis of the muscles of the face. The upper lip and the point of the nose are drawn in the direction of the normal side, the under lip is distorted in a similar manner or hangs downward. Food accumulates between the cheeks and the teeth. The nasal openings are constricted (peripheral paralysis). The animal is unable to close the eye on the affected side, tears flow, the upper eyelid also hangs downward (ptosis). The ear may also be paralyzed (central paralysis).

b) Trigeminal paralysis, caused by paralysis of the motor branches of the trigeminus, results in a paralysis of the muscles of mastication. It causes difficult prehension of food, salivation, dropping of the inferior maxilla, and atrophy of the muscles of mastication.

c) Paralysis of the suprascapularis is characterized by a peculiar form of shoulder lameness in which the shoulder springs outwards when weight is placed on the foot of the involved side; a space variable in size is present between the thorax and the elbow. There afterwards develops a pronounced atrophy of the spinati muscles and the rotaters of the shoulder.

d) Paralysis of the radial nerve, which innervates the extensor muscles of the forearm and limb, especially the extensors of the elbow (anconeus), is only in part a general paralysis of the nerves. In other cases it is a myogenic paralysis of the anconeus (hemaglobinemia, myositis after casting). It is characterized by inability of the involved limb to support the body weight. All of the joints of the foot are flexed, they cannot be extended to support the weight of the body. By pressing backwards on the carpus, the limb may be maintained in a position to support weight. The paralyzed muscles feel relaxed, finally they undergo atrophy.

e) So-called paralysis of the crural nerve is usually not due to paralysis of the nerve, but to that of the extensors of the knee (quadriceps femoris); it may follow azoturia or casting. It results, when supporting weight, in an abnormal flexion of the knee-joint; as a result of paralysis of the extensor muscles extension of the knee-joint is impossible. Chronic paralysis is followed by high-grade atrophy of the muscles of the knee.

f) Obturator paralysis results from pelvic fractures in the vicinity of the obturator foramen (inflammation and compression of the nerve through callus masses). It is characterized by abduction of the involved limb as result of paralysis and atrophy of the adductors.

TREATMENT.—Therapy of nerve paralysis consists in the application of massage, cutaneous irritants, electricity, methodical movements, as well as the subcutaneous injections of strychnine and veratrin. Among the peripheral forms of nerve-paralysis the following have a relatively good prognosis: the facial and the radial, paralysis of the suprascapularis and quadriceps is frequently incurable.

2. INFLAMMATION OF NERVES. NEURITIS.

CAUSES.—Inflammation of nerves is of slight importance in veterinary surgery, it is very rare on the one hand, and on the other it is very difficult to recognize subjective symptoms on the part of the animal. The causes, as in man, are of a traumatic, infectious, rheumatic, and toxic nature. Traumatic neuritis occasionally develops at the central nerve-stump after resection of a nerve, this occurs as a result of inflammatory processes in the immediate vicinity which extend to the nerve. Inflammation of the planter nerves has also been observed in the horse after interfering. Thommassen has described a neuritis of the sacral plexus apparently due to rupture of the nerves from jumping. Hemiplegia laryngis (roaring in horses) is of special importance with reference to its relation to contagious

pleuropneumonia. It occurs as a sequella of this disease, and by many is considered a neuritis of the recurrent nerve which lies in the left pleural sac and is caused by an extension of the inflammatory process from the pleura to the nerve at the point where it passes around the posterior aorta; this leads to unilateral paralysis of the laryngeal muscles. Also, paralysis of the laryngeal muscles which occurs in horses during the course of chronic lead poisoning is considered by Thomassen as merely the result of a primary chronic neuritis of the recurrent characterized by connective-tissue new-formation and degeneration of the nerve. According to recent investigations of von Marek, dourine in the horse is not an affection of the spinal marrow, but an infectious polyneuritis. He found round-celled infiltration and connective-tissue new-formation, especially in the ischiadicus, tibialis, and crural nerves, to some extent, also, in the median, infraorbital, tarsal, and intercostal nerves; according to him the symptoms of paralysis in dourine are of a peripheral nature. An infectious, multiple, peripheral neuritis occurs in animals and men in Dutch-India as a result of eating clodded rice, it is known as beri-beri-disease. According to some stringhalt in the horse is due to a neuritis of the ischiadicus (?). In the domestic animals one often observes inflammatory processes in the optic nerves and the retina: neuritis retrobulbaris, papillitis, and retinitis.

Anatomical Changes.—As in inflammation of other organs, the following forms of neuritis are also recognized: suppurative and interstitial; the first is an acute, the second a chronic form of neuritis. Macroscopically, acute neuritis is characterized by redness, swelling, and a serous or suppurative exudate between the fibrous bundles. Microscopically one finds dilitation of the blood-vessels, small-celled infiltration, nuclear proliferation of the sheath of Schwan, as well as degeneration of the marrow, and axis-cylinders. In chronic neuritis one finds connective-tissue new-formations (induration, schlerosis) with a subsequent degeneration and atrophy of the nerve-fibers. In the case of neuritis interstitialis proliferans of the sacral plexus described

by Thomassen the plexus was four times as thick as normal and presented high grade connective-tissue proliferation with secondary atrophy of the nerve fibers.

SYMPTOMS.—Neuritis of the sensory nerves is characterized by severe pain in the involved area, and paralysis and atrophy of the groups of muscles supplied by the affected nerves. Interstitial neuritis of the sacral plexus results in unilateral, severe muscular atrophy of one side of the hip, and one limb (glutei, biceps femoris, semi-tendinosus). In general, the clinical symptoms are very slight, regardless of enormous pathological changes. Zietschmann observed two cases of chronic interstitial neuritis of the axillary plexus with neuroma formation in cattle, it resulted in pronounced connective-tissue proliferation, no genuine paralysis, but only slight muscular weakness of the affected limb. Treatment consists in the application of nervines (morphia, cocaine, strychnine, veratrin), as well as counter-irritants to the skin, massage, and electricity. As a last resort for neuritis, sensory nerves may be severed (neurotomy), or a section may be cut out (neurectomy), or extracted (neurexairesis).

NEUROTOMY.—For certain incurable, painful forms of lameness in the horse (lameness from ringbone, chronic navicular disease, contracted hoof, chronic tendinitis, etc.) severing the nerve is a valuable palliative remedy. Animals that are otherwise useless are restored to a certain amount of utility. For indications of this operation see Bayer's article in Volume I. of this hand-book. The changes that occur in a nerve that has been severed consist in fatty and granular degeneration of the entire periphery from the severed end of the cut section to its finest branches (descending degeneration). At the same time, however, there begins a collateral anastomosis formation with regeneration of the nerve-tissue from the central end, new nerve-fibers sprout from this stump, extend over the defect, and grow into the peripheral channels so that the function of the peripheral nerves is restored again after a certain length of time. In suppurative infection of the operative wound, as well as in continued traction on the central end of the severed nerve, there develops a chronic interstitial inflammation of the central stump with the formation of a neuroma (see page 121).

DISEASES OF VESSELS.

1. DISEASES OF ARTERIES.

1. INFLAMMATION OF ARTERIES. ARTERITIS.

FORMS.—One recognizes, first, an endarteritis, mesarteritis, and periarteritis according to the location of the disease in the inner, middle or outer coat of the arterial wall. According to the causes and course, one further recognizes an aseptic, and septic or suppurative, a traumatic and hematogenic, an acute and chronic, as well as a deforming, ossifying, and obliterating arteritis; the latter is characterized by closure of the vessels. The acute suppurative and chronic deforming forms of arteritis are of special practical importance.

a) Acute suppurative arteritis is the result of an infection of the arterial wall with staphylococci or streptococci. It either originates in the adventitia (periarteritis purulenta), or it may extend from the injured intima (suppurative thrombo-arteritis), or it may result from an embolism in the blood (pyemic metastasis). Suppuration of the intima results in a loss of the endothelium (suppurative necrotic endarteritis).

b) Chronic deforming arteritis or arterioschlerosis (atheroma or atherosis of the vessel) is a multiple, focus-like, ulcerative endarteritis with connective-tissue thickening of the intima; the latter becomes necrosed and defective (so-called artheromatous ulcers); it is followed by fatty degeneration and calcification of the media. It leads to induration, stenosis, and obliteration, or dilitation and rupture of the diseased vessel-walls. While it is very frequent in man (symptom of old age, alcoholism, etc.), it is rarely a surgical defect in animals (iliac arteries, femoral arteries, axillary arteries). Endarteritis and dilitation of the anterior mesenteric artery as a result of strongylus armatus is of far greater importance for internal pathology. Cattle appear to be more predisposed to arterioschlerosis (endaortitis ossificans).

Atheroma of the aorta with a subsequent meningeal embolism is occasionally observed in horses.

2. DILITATION OF ARTERIES. ANEURYSM.

FORMS.—Aneurysms are divided into diffuse and circumscribed. The circumscribed forms are either cylindrical (aneurysma cylindriforme), or spindle-shaped (A. fusiforme) or sac-like (A. sacciforme). A diffuse aneurysm is also termed angioma arteriale racemosum (aneurysma racemosum, anastomoticum, cirsoideum); it is a variety of new-formation, namely, angioma arteriæ plexiformæ (angioma racemosum). Aneurysma arteriovenosum (varix aneurysmaticus, varix arterialis, arteriophlebectasia) is a special form due to the union of an artery and a vein (phlebotomy, castration of cattle). Aneurysma dessicans results from rupture of the intima and media, the adventia is raised by the pressure of blood (so-called false aneurysm). In rare cases the walls of the aneurysm are formed in the liver, intestines and other organs.

CAUSES.—In the horse the most frequent cause is the strongylus armatus, it is most active in the anterior mesenteric artery, where it produces a chronic deforming endarteritis. A similar cause results in dilitation and thrombosis of the femoral and iliac arteries as well as the axillary arteries. In other cases the aneurysm may have a traumatic origin (punctured wound), it may result from emboli, or from degenerative conditions of the vessel-walls when such conditions are exposed to the influence of concussions (blows, kicks) or strong muscular exertion (increased blood-pressure.)

OCCURRENCE.—When compared with man, surgical forms of aneurysm are very rare in the domestic animals (infrequency of arterioschlerosis). In the horse they have been most frequently observed in the following places: the aorta, the femoral and internal iliac arteries, in the carotid, the bracial, the femoralis, the popliteus, ischiadicus, facial, palatine, nasal, and internal

maxillary arteries. Aneurysma arteriovenosum has been observed in cattle in the vessels of the spermatic cord (spermatic artery and vein), following phlebotomy in the horse (jugular and carotid), as well as after injuries in the vicinity of the masseters (masseteric artery and vein).

SYMPTOMS. —Those that have a superficial location are characterized by a pulsating swelling, on compression of the artery by which it is supplied it either diminishes in size or entirely disappears. On palpation and auscultation of the tumor friction sounds may occasionally be recognized in the form of a buzz or hiss on the inner wall of the aneurysm. Pressure on the neighboring nerves occasionally results in continued and severe pain. One also observes erosion of neighboring organs, even atrophy of the dorsal and cervical vertebræ or the sternum. Aneurysms frequently lead to rupture and hemorrhage, or to sudden death from thrombosis and emboli. Spontaneous healing by means of obliteration and calcification is seldom observed. The most important forms of aneurysms in veterinary science are characterized by the following symptoms :

a) AORTAL ANEURYSM results in a dilitation of the sinus of Valsalva at the origin of the aorta. In a horse they become larger than a man's head. Aneurysms in the abdominal cavity may become adherent to the neighboring organs (stomach, colon, small intestine); they also involve these organs and may lead to an erosion of the vertebral column. In most cases they produce no visible symptoms of disease for a long time or during the life of the animal ; other cases suddenly terminate in death as a result of internal hemorrhage, previous marked symptoms being absent. Death from internal hemorrhage often follows concussion (casting, falls), or it may suddenly follow severe exertions ; the animal quivers, is very dyspneic, tumbles down and dies in a very short time. Peculiar paroxysmal symptoms without immediate death as a direct result have also been observed. Lustig observed the following symptoms in a horse after severe exertion : weakness in the hind parts, sudden falling, pronounced dyspnea, as well as epilepti-

form cramps in which the head and neck were curved backwards and the feet extended, the animal rose again after ten or fifteen minutes. Symptoms of vertigo were constant in another horse that was affected with aneurysms in the pulmonary arteries. Barrier observed the following symptoms in a dog affected with aneurysm of the posterior aorta : emaciation regardless of a good appetite, pronounced debility, severe dyspnea on slight movement, and finally paralysis of the hind parts (symptoms of heart weakness). In a horse with an aneurysm the size of a man's head in the thoracic aorta, Schmidt found a buzzing tone over the vertebral column that was synchronous with the action of the heart ; the animal was unable to take food, and traveled with a straddling and stiff gait in the hind limbs. Rupture of the aneurysm into the stomach (Vogel), and into the rectum (Labat, Cadeac, Duchene) has occasionally been observed. Mettam saw roaring (paralysis of the recurrent) in a mare as a result of an aortal aneurysm the size of one's head.

b) Dilitation and thrombosis of the femoral and internal iliac arteries (seldom axillary) in the horse may be due to the following causes : diseases of the inner layer of the artery (endarteritis) with the collection of a fibrinous coagulum on the surface and stenosis of the lumen, or embolic obliteration of the aortic branches from thrombi dislocated from the heart or from aneurysms. One most frequently finds thrombi in both external iliac arteries, or in the femoral arteries, and in both internal iliac arteries. They are less frequently found in the axillary or brachial arteries, and rarely in the lumbar arteries. The terminations of the aorta and the origin of the arterial branches are usually dilated ; the walls are thickened and affected with atheromatous degeneration ; the intima is fatty, cloudy, calcified, and covered with ulcers. Within the vessel there is located a stratified and organized firm thrombus, clear in color, the lumen is more or less stenosed, often there remains only a narrow canal. Frequently the thrombus extends forward towards the aorta or backward into the arterial branches, it may be confined to the

aortic bifurcation. Occasionally the external or internal iliac arteries of one side are completely filled with the thrombus. In addition to the thrombus there frequently develops a secondary compensatory hypertrophy of the heart. As a result of softening of the thrombus, emboli may pass into the peripheral arteries of the extremities. The described thrombi usually present no symptoms of disease while the animal is at rest. The very peculiar, characteristic symptoms of this disease are first observed after light or severe exercise in the wagon, under the saddle, or on the training ground.

In thrombosis of the femoral and internal iliac arteries which usually occurs in horses, seldom in cattle, one first observes a progressive weakness in one or both posterior limbs. The animal presents a characteristic paralysis which develops very suddenly. It usually involves one side, the animal has a staggering gait, strikes the affected hind foot against that of the opposite side, either brings the weight to bear only on the toe or drags the limb, trembles, falls down and lies jerking the limbs for a few minutes, and then lies back exhausted. At the same time the frequency of the respiration is very rapidly increased, the heart beat is bounding and accelerated, the visible mucous membranes are strongly injected, perspiration breaks out over the entire body. The temperature of the paralyzed extremity is usually subnormal, pulsation is frequently absent in the tibial and planter arteries. After a few minutes the animal rises again, the symptoms of paralysis gradually disappear, after which recovery is soon complete. From a diagnostic standpoint, the fact that the disease can be produced experimentally by forced exercise is of great importance. On rectal examination of the thrombosed area one finds the following condition: the aorta and its arterial branches are dilated, thickened, unyielding, filled with a long firm substance and non-pulsating on the affected side. In rare cases thrombus formation results in the production of emboli in the peripheral arteries and results in gangrene of the limbs.

Thrombosis of the axillary arteries, a less frequent condi-

tion, is introduced by simple lameness of the involved side. The animal begins to stumble when moving, makes false steps, trips, drags the toes, is unable to raise the limbs, quivers on the affected side, and finally falls down. Deranged respiration, accceleration of the heart beat, and congestive conditions are not usually observed. After a short time the function is again restored.

c) Aneurysma arterio-venosum of the spermatic cord occasionally follows castration of bulls. Along the course of the spermatic cord there develops a prominent, soft, cylinder-like swelling, following ligation, twisting, or tearing of the cord. It is due to fusion between the spermatic artery and vein, so that the blood passes from the former into the latter (Gurlt, Collin, Kitt).

d) Aneurysm of the anterior mesenteric artery is of no surgical importance; see text-books on special pathology.

TREATMENT.—The radical treatment of aneurysms that are accessible consists in extirpation of the dilated vascular portion after carefully ligating the afferent and efferent vessels. Under certain conditions, however, the operation is very dangerous as it frequently results in anemic necrosis of organs located peripherad to the ligature. They have in man, therefore, been treated as follows: methodical compression; injection of irritants (liquor ferri chloridi, extract of ergot, alcohol); acupuncture and filipuncture (application of a copper suture, silver suture, iron suture, suturing with a horse hair); as well as galvanopuncture or electropuncture (galvano-caustic punctures with needles).

CASUISTIC.—Steinmeyer has described an aneurysm of the right carotid at the heighth of the sixth cervical vertebra; it occurred in an eighteen-year-old horse that died very suddenly. There was a swelling on the ventral surface of the throat as large as a man's head, he found it to be a spindle-shaped aneurysm four and one-half centimeters in length with a transverse rupture three centimeters long, the intima at this spot was rough and covered with thrombi. Mouquet has observed a similar aneurysm of the left carotid in the pectoral region (compressible tumor with friction sound).—An aneurysm of the facial artery and its branches in a Simenthal cow has been observed by Vogel. It extended from the region where the artery winds around the face to the

end of the angular artery of the eye ; it was sinuous in its course and presented sac-like dilitations, pulsations were well marked, on auscultation buzzing and hissing sounds were recognized. An aneurysm of the posterior tibial artery in an ox has been described by Furlanetto: it formed an elastic, painless, pulsating, conical swelling on the inner surface of the tibia, it was fifteen centimeters in length and parallel to the saphenic vein. Blaise observed an aneurysm of the pharyngeal artery in a horse, fatal rupture occurred resulting in symptoms of angina. Nouquet has observed an aneurysm of the artery that runs parallel to the saphenic vein : it was the result of phlebotomy and terminated in fatal hemorrhage. An aneurysm of the arterior tibial artery with calcification of the walls has been extirpated by Straube. Many cases of aneurysma racemosum on the under surfuce of the tail in cattle have been recognized by Sand.

3. RUPTURE OF LARGE ARTERIES. VASCULAR RUPTURE.

CAUSES.—Rupture of large arterial branches is due to a direct injury, or it may have an indirect origin by means of concussion, falls, excessive muscular exertion—difficult pulls, during severe exertion while the animal is cast, in the act of vomiting, etc. In the last named cases of so-called spontaneous rupture, predisposition to rupture is occasionally present in the form of pathological changes in the arterial walls. The following are among the pathological conditions that may occur: aneurysms, arterioschlerosis, adipose degeneration of the vessel-wall, as well as erosion of the latter through new-formations. In many cases of spontaneous rupture of the aorta in the horse no visible microscopic changes are present in the vessel-wall.

OCCURRENCE.—Rupture of the large vessels is most often observed in the aorta and its branches as well as in the pulmonary arteries. The symptoms of internal hemorrhage are as follows: staggering, tumbling, sudden collapse, paleness of the visible mucous membranes, cold extremities, as well as a weak and finally imperceptible pulse, occasionally one also observes cerebral convulsions, and amaurosis (anemic adipose degeneration of the retina), as well as vomiting.

Ruptures of the aorta usually occur at its origin immediately behind the semilunar valves in the vicinity

of the sinus of Valsalva; at this point the blood-pressure is greatest, the walls are apparently thin and in most cases somewhat dilated; these regions form, therefore, an area of predilection for the formation of aortal aneurysms. Rupture of the aorta occurs most frequently in horses; it is observed after casting, jumping, and falling. The blood flows into the pericardium which is found distended with blood on post mortem. Rupture of the anterior aorta is often caused by wagon poles that penetrate the tissues.

Ruptures of the pulmonary arteries, likewise, are observed in horses after casting. Severe hemoptysis (coughing blood) as a result of the rupture of an aneurysm of the pulmonary artery into a large bronchus was observed in one case. Other ruptures that may be mentioned are: rupture of the femoral arteries and obturator arteries in fractures of the pelvis; the internal iliac arteries in fracture of the last lumbar vertebra; the renal arteries from concussions; the colic arteries, when dilated with aneurysms, from casting; the cecal artery as a result of a sarcoma; the diaphragmatic artery from blows; the carotid artery as a result of erosions from strangles abscesses; the posterior aorta through erosions from sarcomata; the axillary artery from a severe pull; the left cervical artery, etc., from fractures.—Treatment of these ruptures is not usually possible. Ruptures of the palatine artery, internal carotid artery, etc., must be treated by ligation of the carotid artery.

OBLITERATION.—Adhesion and obliteration of the vessels as the result of endarteritis obliterans is seldom observed in the domestic animals. Pirl has observed an obliteration of the posterior aorta in the horse. The aorta formed a solid cord between two aneurysms, it was about the thickness of one's finger; anterior to the area of adhesion there branched finger-thick, newly formed collateral vessels. Eligio has described an obliteration of the iliac artery with symptoms of paralysis. I have recently (1904) observed a case of stenosis of the aorta in a horse (apparently congenital) that resulted in clinical symptoms of thrombosis of the internal iliacs.

EMBOLI.—These result from a solution of thrombic masses in the heart, in the aneurysmatically dilated anterior mesenteric artery, femoral artery, etc., especially in the horse. Emboli in the pododerm

lead to necrosis and loss of the horn capsule; emboli of the middle rectal artery to paralysis of the rectum (Casper); emboli of the ophthalmic artery to sudden blindness (Arnold).

II. DISEASES OF VEINS.

1. INFLAMMATION OF VEINS. PHLEBITIS.

FORMS.—As in arteritis, one also distinguishes in inflammation of the veins, an endophlebitis, mesophlebitis, and periphlebitis; an acute and chronic; an aseptic and septic (suppurative) phlebitis. Suppurative necrotic phlebitis, or suppurative thrombophlebitis is of special practical importance. It either occurs during the course of a phlegmon or from suppurative infection of venous thrombi through the entrance of pus-forming bacteria from without, or in pyemia from within, that is, from the blood (embolic, pyemic, metastatic).

SYMPTOMS.—Phlebitis is characterized by a cord-like, nodular, firm thickening and induration along the course of the veins; passive edema also develops in the vicinity of the diseased vein. The nodular formation is due to localization of the inflammatory process at the valves as a result of retardation and engorgement of the blood at these points. Induration of the veins is the result of thrombus formation in the blood and thickening of the walls. Through the release of infected portions of the thrombus suppurative metastases of distant organs may result, this is especially true of the lungs (pyemia).

With reference to the occurrence of phlebitis in the domestic animals it may be remarked that formerly, especially in the horse, it was more frequently observed than now (phlebitis of the jugular following phlebotomy, so-called phlebotomy fistula). Suppurative omphalophlebitis of foals and calves (suppurative thrombophlebitis of the spermatic vein with consecutive pyemia; so-called foal-lameness) is less common since the introduction of umbilical antiseptics. On the other hand, the recent employment of intravenous injections of chloral hydrate

in the horse has again introduced thrombosis of the veins and phlebitis of the jugular. Phlebitis in the vicinity of wounds and phlegmons is also of practical importance; inflammation of the saphenic vein in the course of phlegmons of the posterior limb ("Einschuss") is not very common, the same is true of the internal iliac and femoral veins, the vena digitalis interna, radialis, brachialis and cephalica, as well as thrombophlebitis of the nasal mucous membrane which occasionally leads to suspision of glanders in the horse. According to Zschokke the latter is characterized by the following symptoms: the septum nasi is dark-red in color; it is covered with stratified, light-yellow or reddish-grey wreath-like nodules, or cord-like elevations from one-half to two mm. in diameter; they consist of white venous thrombi that have their origin in a primary phlebitis. Ulcer formation as well as a suppurative or caseous exudate is wanting, this differentiates the condition from glanders.

2. DILITATION OF VEINS. VARIX. PHLEBECTASIA.

CAUSES.—Similar to aneurysms, dilitations (varices, phlebectasia) of the veins are found. Chronic inflammation of the walls of the veins, especially the intima (chronic endophlebitis) is the most frequent cause. In addition, traumatic influences, as well as ulcerative and congenital dilitations of the veins must be considered. They are favored by local and general vascular engorgement.

SYMPTOMS.—Varices are present either in the form of circumscribed nodular (spindle-shaped, sac-like, cylindrical), or diffuse swellings along the course of the veins of the skin and mucous membranes. They have a tendency to become hemorrhagic and form ulcers (periphlebitis); they also result in thrombus formation (suppurative thrombophlebitis, pyemia), and in rare cases in calcification and caseation (so-called vein stones, phleboliths). In comparison with man varices in animals are very rare. Varices of the mucous membrane of

the rectum, known as hemorrhoids, are very uncommon in animals. The same is true of dilitations of the veins of the lower limbs following repeated pregnancy (so-called varicose veins). As a rule the diagnosis of such conditions is erroneous, for example, in the dog that condition recognized as hemorrhoids is usually a pathological condition of the anal glands; varix of the saphenic vein in the horse (so-called blood-spavin) hardly ever exists. The cause of this variation between man and animals is due to the fact that chronic inflammatory conditions of the veins are far less common in animals than in man. In man many affections of the heart and chronic pulmonary diseases, as well as the upright position of the body, and pregnancy (pressure of the pregnant uterus on the veins) induce venous congestions more readily than in animals. Varices of the rectal mucous membrane (genuine hemorrhoids) have only occasionally been observed in horses, cattle, and dogs. Eckart found the following conditions in a horse: numerous nodules and cysts at the margin of the anus and termination of the rectum, they varied in size from that of a pea to that of a cherry, were smooth on the surface, slightly bluish in color, painful and hemorrhagic. Varices also occur in the spermatic cord (so-called varicocele), in the milk-veins of cows (hemorrhagic swellings about the size of a hen's egg, Liebl); in the vicinity of the anus and scrotal covering in dogs (characterized by ulcer formation and hemorrhage; Möller, personal observations); in the vesical mucous membranes of the dog (chronic hemorrhage of the bladder, Frick); on the anterior margin of the masseter muscle in the form of a varix of the facial vein in a remount horse (Preuss. Mil.-Ber. 1897); on the external mammary vein of the horse (personal observation); on the saphenic vein of the horse (Teply); as well as congenital new-formations of the skin of foals (W. Eber). Varix aneurysmaticus in the form of an opening of the spermatic artery into the spermatic vein after castration of bulls has been seen by several observers (Gurlt, Prinz, Meyer, Wagenfeld, Collin, and

others); it produces a pulsating, buzzing swelling in the cord.

TREATMENT.—This consists in operative removal, or ligation. In addition to these methods, those used in human surgery may be employed; namely, removal with the cautery, ignipuncture (perforation with the Paquelin), the injection of medical agents (ergot, alcohol, concentrated carbolic acid), as well as methodical compression. The latter methods may be experimentally employed.

RUPTURE OF LARGE VEINS.—The following ruptures with fatal internal hemorrhage have been observed, especially in the horse: rupture of the portal vein, the pre- and post cava, and the mesenteric vein. Ruptures of the jugularis, axillary vein, vena cephalica and saphena are not rare.

III. DISEASES OF LYMPH-VESSELS.

1. INFLAMMATION OF LYMPH-VESSELS. LYMPHANGITIS.

CAUSES.—Inflammation of the lymph-vessels is usually due to a wound infection disease induced by the entrance of pus-forming bacteria into the open lymph-vessels. It is most often found, therefore, in the following places: in the vicinity of infected, suppurative wounds; in phlegmons; following too early incisions of hematomata in the region of the buttocks and limbs; as a result of fistulae of the neck, fistulous withers, and injuries from saddle-galls. There also exist specific forms of lymphangitis; namely, in horses during the course of glanders and strangles, as well as so-called pseudo-glanders (lymphangitis ulcerosa sui generis, malleiforme lymphangitis); in cattle as a symptom of tuberculosis of the skin; in dogs during the course of so-called dog-distemper. A plague-like infectious lymphangitis with symptoms similar to glanders, but with a benign course, is observed in horses and mules in the French Army in Africa (Farcin d'Afrique, Lymphangite farcinoide); the lymph-vessels of the skin swell into cords and are covered with granulating ulcers, from the ulcers there is a discharge of normal pus. This "African" glanders

is also frequently observed in Southern France, Italy, Egypt, Russia, Japan, among American horses in the Philippines, etc. It is caused by a fungus-like parasite, saccharomyces (cryptococcus) farcinosus (lymphangitis saccharomycotica, fungus-lymphangitis). So-called worm in cattle is a similar disease (Farcin du boeuf).

SYMPTOMS.—Lymphangitis is characterized by bead-like swellings along the course of the lymph-vessels, that is, a cord-like swelling interrupted by nodules. It is frequently the result of inflammation of neighboring lymph-glands (lymphadenitis). Along the course of the bead-like swellings there occasionally develops, especially at the seat of the valves, numerous small abscesses (horse-distemper, dog-distemper). Chronic lymphangitis leads to pronounced thickening of the skin (elephantiasis in glanders of the skin).—Treatment consists in incision of the abscesses, as well as in the application of antiseptic fluids and ointments.

2. DILITATION OF LYMPH-VESSELS. LYMPHANGIECTASIS.

CAUSES.—Lymphangiectasis is usually congenital and belongs in part to the chapter on tumors. It includes the so-called congenital elephantiasis, macroglossia, and macroscelia (see page 123). In contrast to this form there is, however, an acquired dilitation of lymph-vessels; it is especially observed after chronic recurrent inflammations of the skin and subcutaneous tissue (inflammatory form of elephantiasis). So-called lymph-cysts—cystic dilitations of the lymph-vessels—are a special form; these must not be confused with lymph-extravasates, that is, effusions of lymph as a result of subcutaneous rupture of lymph-vessels; or lymph fistulae, permanent ulcer-like openings in the lymph-vessels following injuries.

DISEASES OF GLANDS.

GENERAL REMARKS.—The general surgery of glandular affections in veterinary science is of importance only as applied

to certain glands, namely, the lymph-glands and the milk-glands which present a group of important diseased conditions. From a surgical standpoint inflammation of the glands most frequently demands treatment. Glandular inflammations (lymphadenitis, mastitis) may be due to various causes and present extremely variable forms. From an etiological standpoint the following forms are recognized: traumatic, infectious, and rheumatic inflammation of the glands. In addition, there occurs a primary or independent form in contrast to a secondary or symptomatic form the latter is only a partial symptom of general disease (lymphadenitis in strangles, glanders, tuberculosis; mastitis in foot-and-mouth disease). According to the path of infection the following classification is observed: hematogenous, lymphogenous, and galactogenous inflammations of the milk-glands. According to the course inflammation of glands is classified as acute and chronic. The classification according to the anatomical character of the inflammation is of special importance. According to this classification the following forms are recognized: parenchymatous, interstitial, suppurative, phlegmonous, catarrhal, and specific. Parenchymatous inflammation involves the genuine secreting glandular substance; the interstitial form applies to the interglandular connective tissue; the catarrhal to the excretory ducts and the collecting mechanism (milk-cysterns) of the glands.

In the following will be described only inflammation of the two most important types of glands from a surgical standpoint, namely, the lymph-glands and the milk-glands. The description is brief and from a general standpoint.

I. INFLAMMATION OF LYMPH-GLANDS.

LYMPHADENITIS.

CAUSES.—Inflammation of lymph-glands is usually infectious in character. The infectious material enters either through a lymphogenous path, from without to within through the medium of the lymph-vessels (concentric lymph-

angitis), or hematogenous, carried to the lymph-glands by the blood. Lymphadenitis is most frequently observed as a result of the following conditions: infected wounds and phlegmons, nasal catarrh, suppurative alveolar periostitis, empyema of the sinuses of the head, pharyngitis, etc., it may further develop in a specific form in strangles, glanders, tuberculosis, actinomycosis, and botryomycosis. From an anatomical standpoint one recognizes a parenchymatous, interstitial, and suppurative lymphadenitis. Perilymphadenitis is not uncommon, that is, an inflammation of the connective tissue in the vicinity of the gland that leads to adhesions between the latter and the surrounding tissues (inferior maxilla). In the horse lymphadenites are most often observed in the intermaxillary lymph-glands; in cattle in the lymph-glands of the neck and udder.

SYMPTOMS.—a) Parenchymatous lymphadenitis is characterized by swelling of the gland, it is usually acute in development and is accompanied by slight degree of pain. Afterwards the swelling either becomes resorbed, or the parenchymatous lymphadenitis changes into the suppurative or chronic form. It is most often observed as a wound infection disease following injuries, as well as subsequent to catarrh of the mucous membranes.

b) Suppurative lymphadenitis is especially observed during strangles in the horse. It is characterized by severe swelling and pain as well as fever; it usually terminates in fluctuation and abscess formation. If the pus is not discharged outwards it becomes thickened (caseation), or it is resorbed by the blood (pyemia, septicemia, petechial fever).

c) Chronic interstitial lymphadenitis is characterized by the following symptoms: a painless, hard, circumscribed swelling of the gland; occasionally it becomes adherent to the underlying tissues, and it may contain hard nodules (glanders, tuberculosis, chronic catarrh).

TREATMENT.—Chronic interstitial lymphadenitis is in-

curable, occasionally it is necessary to extirpate the enlarged gland for diagnostic purposes. Suppurative inflammations are treated by means of incisions and antiseptic irrigation. The parenchymatous form is treated with moist warmth, parenchymatous injections, camphor ointment, iodoform ointment, grey ointment and other resorptives.

2. INFLAMMATION OF THE UDDER. MASTITIS.

CAUSES.—In cattle, infections are the most frequent causes of mastitis, it is seldom of traumatic or rheumatic origin. The infection may have a galactogenous, lymphogenous, or hematogenous entrance. As a result of bacteriological investigations in recent years, in addition to tubercle-bacilli, actinomyces and botryomyces fungi, a number of specific organisms have been found to cause mastitis. Ordinarily they gain entrance through the duct of the teat (galactogenous infection). The following are the most important:

a) Bacterium phlegmasiae uberis, identical with the colon bacillus.

b) Streptococcus agalactiae contagiosae and other streptococci.

c) Staphycococcus mastitidis.

d) Staphylococcus mastitidis gangraenosae.

e) Galactococcus versicolor, fulvus, etc.

f) Bacillus pyogenes.

g) Micrococcus tetragenes.

FORMS.—1. Parenchymatous mastitis is partly galactogenous through the entrance of bacteria of mastitis from without, partly hematogenous, for example, during the course of foot-and-mouth disease (symptomatic mastitis), it affects the columnar epithelium of the alveoli and small milk-ducts. It leads to a firm, painful, febrile swelling and pronounced enlargement of the inflamed quarter of the udder. Milk from the affected part contains a flocculent coagulum and

fibrin, sometimes it is even yellowish and wheyish, or even colored with blood, finally the milk-secretion is entirely suspended. If resorption does not occur there develops, either a permanent inflammatory hypertrophy of the udder with marked enlargement and induration, or an atrophy with shrinking and permanent diminution in size of the affected quarter. In other cases it passes into a suppurative and even gangrenous form of mastitis.

2. Catarrhal inflammation of the udder (catarrh of the udder) is localized especially on the mucous membranes of the teat-canal (squamous epithelium), the milk-cysterns and large milk-ducts (columnar epithelium). In the beginning the gland itself is either slightly swollen or normal in size. It is characterized by the watery, flocculent, wheyish condition of the milk. Afterwards it leads to induration, stenosis and obliteration of the teat-canal, as well as to the formation of connective-tissue septa in the milk-cysterns which lead to hard milking, drying up of the milk (agalactia), and atrophy of the affected quarters. In other cases catarrhal inflammation extends to the interstitial tissue and results in chronic induration with permanent increase in size (pseudo-hypertrophy) of the diseased quarters. Occasionally it assumes a contagious form ("gelber Galt," agalactia catarrhalis contagiosa).

3. Phlegmonous mastitis (inflammatory edema of the udder) is an infectious inflammation of the skin and subcutem, as well as the interglandular connective tissue of the involved quarter. It is characterized by a firm, painful, diffuse, hot, febrile swelling of the affected quarter without qualitative changes in the milk in the early stages of the disease. It is a result of infection from without (traumata), or within (accompanying symptom of parenchymatous mastitis) and should not be confused with the non-painful and non-febrile, physiological stagnation edema of cows advanced in pregnancy. The chronic course results in chronic induration and atrophy of the diseased quarter.

4. Chronic interstitial or indurative mastitis consists in an inflammatory new-formation of connec-

tive tissue with atrophy of the genuine parenchyma of the udder. It may develop independently as a chronic inflammation during the period when the animal is not giving milk, when it leads to a painless, hard, often very pronounced enlargement of an entire quarter of the udder; the milk is watery and flocculent. It often results from a previous acute, catarrhal, parenchymatous, or interstitial, as well as a tubercular and actinomycotic mastitis; in the latter cases the nodular swellings are frequently painful during the early stages of the disease.

5. Suppurative inflammation of the udder, abscess of the udder (suppurative, apostematous, stereptococcal, staphylococcal mastitis) is a circumscribed suppurative liquefaction of the parenchyma of the udder during the course of parenchymatous and catarrhal mastitis. It is characterized by high fever, fluctuating areas on the udder, as well as a purulent condition of the milk, it occasionally leads to the formalent of milk-fistulæ.

6. Necrotic inflammation of the udder is especially common in sheep through the influence of specific microörganisms (micrococcus mastitidis gangraenosæ); it is less frequent in cows where it occurs during the course of severe parenchymatous mastitis of a putrid character. During the course of a suppurative mastitis necrotic portions of tissue may be sloughed off (sequestration, mortification or mummification of the udder). In these cases the milk is fetid and ichorous in character; the necrotic portions of the udder are discolored and sloughed off.

With reference to tuberculosis, actinomycosis, and botryomycosis of the udder see pages 167, 159 and 163.

TREATMENT.—Treatment varies according to the form of mastitis. In general the following methods are important: frequent milking, the application of antiseptic agents (ointments containing borates or salicylates), early incision of abscesses, removal of necrotic portions, amputation of single quarters, operative treatment of stenoses and partitions in the teat-canals and milk cysterns.

Massage is contraindicated in all forms of infectious mastitis. For further details compare with text-books on special surgery and obstetrics.

SURGICAL DISEASES OF THE SKIN, SUBCUTEM AND MUCOUS MEMBRANES.

I. SURGICAL DISEASES OF THE SKIN.

1. INFLAMMATION OF THE SKIN. DERMATITIS.

CAUSES.—The causes of inflammation of the skin are traumatic, chemical, thermic, infectious, and specific in character (dermatitis traumatica, caustica, combustionis, erysipelatosa, suppurativa, malleosa). According to the course and extent one recognizes a circumscribed and diffuse, superficial and deep, acute and chronic dermatitis.

FORMS.—From a practical standpoint it is important to differentiate between the following anatomical forms of inflammation of the skin :

a) Erythematous dermatitis or erythema of the skin consists of an inflammatory hyperemia of the skin. According to the causes the following forms are recognized: erythema traumaticum (pressure, rubbing); toxicum or ab acribus (irritating chemicals, black soap in dogs); caloricum and solare (heat, burning of first degree, action of the sun); as well as exanthematicum (symptomatic erythema in swine-erysipelas). Small, circumscribed erythema is termed macula; the multiple form is termed exanthematous roseola. Inflammatory active hyperemia must not be confused with passive hyperemia or vascular engorgement (livid, cyanotic); the former is characterized by a clear, arterial color of the reddened skin.

b) Serous dermatitis, when diffuse, is termed inflammatory edema (serous infiltration of the cutis); while the circumscribed form is termed vesicular eczema (multiple vesicles), and bullous dermatitis (large

vesicles beneath the epidermis) ; urticaria or pomphus indicates a circumscribed serous infiltration.

c) Suppurative dermatitis is the result of an infection of the skin with pus-bacteria. It is either superficial or diffuse (suppurative dermatitis), or assumes the form of a circumscribed collection of pus beneath the epidermis (pustular dermatitis, pustule, pus-vesicle). Acne and furuncle is a multiple, suppurative inflammation of the skin confined to the hair-follicles (suppurative folliculitis).

d) Hemorrhagic dermatitis occurs symptomatically in anthrax, either diffuse in the form of hemorrhagic edema, or circumscribed in the form of carbuncles. Hemorrhagic dermatitis may also have a traumatic origin (contusion), or result from a complication of infection with simple hemorrhage (petechia, vibices, ecchymoses, hematoma, suffusion).

e) Gangrenous dermatitis or necrotic dermatitis (necrosis, gangrene) follows burning and freezing, application of caustics, and contusions, as well as the action of certain infectious materials (necrosis bacillus) ; compare with the chapter on gangrene. Ulcerative dermatitis is a similar form ; compare with the chapter on ulcers.

f) Chronic hyperplastic dermatitis occurs partly as a chronic indurative dermatitis or schlerosis (schleroderma, pachyderma, elephantiasis, tyloma), partly as a verrucose dermatitis ("Straubfuss" bristle foot, "Ingelfuss" hedgehog-foot), partly as a squamous inflammation (callosities, squamous eczema).

The treatment of dermatitis of the skin consists in the application of antiseptics, astringents, protective agents, etc.

ACNE AND FURUNCULOSIS.—It is customary to employ these terms to indicate that form of suppurative dermatitis which is confined to the follicles of the skin (suppurative folliculitis). The smaller nodules are termed acne ; the larger, pustule-like nodules which lead to necrosis of the follicles are termed furuncles. They are most often found in the region of the saddle and girth in the horse (so-called saddle-mange, callosity, nodular enlargement, lichen), as well as on the skin over the bridge of the nose in dogs (muzzle, pustular form of acarus

mange); they have also been observed in cattle (udder), and sheep (abdomen). Treatment is purely surgical (incision, curettage, excision).—In contrast to furuncle, carbuncle forms a specific, sanguino-gangrenous, circumscribed inflammation of the skin and mucous membranes due to the anthrax bacillus. (In man, several furuncles arranged in a group are also termed carbuncle).

ECZEMA AND EXANTHEMA.—Eczema is a multiple dermatitis caused by external irritants; it runs a typical course and assumes various forms; namely, aczema erythematosum, vesiculosum, papulosum, pustulosum, madidans, crustosum, impetigenosum, and squamosum. That form of dermatitis found on the volar surface of the fetlock, designated as scratches, is of special surgical importance. According to the degree of inflammation it is termed eczema erythematosum, madidans, crustosum, impetigenosum, squamosum, etc., and may be designated respectively as dermatitis erythematosa, suppurativa, gangrenosa, etc. Exanthema, likewise, is a multiple inflammation of the skin; it is, however, only a symptom of internal disease, and is not, therefore, of surgical importance (vesicular exanthema in foot-and-mouth disease, exanthema of small-pox, exanthema of swine-erysipelas, strangles, dog-distemper, etc.). Exanthema of the mucous membrane is termed enanthema. (For further details concerning exanthema and eczema see: Friedberger and Fröhner, Special Pathology. Sixth Ed., Vol. I.).

2. BURNS. COMBUSTION.

CAUSES.—Inflammation of the skin as a result of burns (dermatitis combustionis) is rarely observed in the domestic animals, except when heat is used as a therapeutic agent. In horses and cattle it is usually due to fires in the stable, burning the pododerm with a hot iron, contact with electric wires (street railways), hot inhalations, and taking hot food. Cats and dogs are burned with boiling water or hot milk. In horses, in addition to burns of the skin and pododerm, the mucous membranes of the respiratory apparatus are burned by inhalations of hot air during conflagrations. Extensive burning of the skin and mucous membranes is very dangerous.

DEGREE. According to the duration and intensity of the caloric influence, three degrees of burning are recognized:

a) The first degree is characterized by a mere redness of the skin (dermatitis combustionis erythematosa),

which may be combined with a slight serous infiltration.

b) The second degree is characterized by the formation of blisters (dermatitis combustionis bullosa); there is a circumscribed collection of serous exudate between the epidermis and rete Malpighi; a croupous inflammation exists on the mucous membranes.

c) The third degree consists in the formation of an eschar (dermatitis combustionis escharotica), whereby the burned portion becomes necrotic (dry gangrene); afterwards, as the result of a suppurative, demarking inflammation it is sloughed off. Necrosis of the pododerm in horses is especially dangerous (exungulation). Complete charring of an organ has been termed burning of the fourth degree.

In addition to local changes, extensive burning is also accompanied by severe general disease and fatal results. Experience in men has demonstrated that death is certain when more than half of the surface of the body is involved, even when in the form of the first degree. The result is usually fatal when a third of the surface of the body is burned. I have learned by personal observations on horses that, under certain conditions, burning may be fatal when only a fifth or a tenth of the surface is affected; the animal suffers from an attack of hemoglobinuria. These results are especially common when the mucous membranes of the respiratory tract are simultaneously affected from inhalations of hot air. Such cases present on post mortem, in addition to the changes on the skin, fibrinous laryngitis, bronchitis, and pharyngitis, glossitis and edema of the lungs, hemorrhagic gastroenteritis, hemoglobinuria, infarcts of hemoglobin in the kidneys, hemorrhages in the spleen and heart, as well as parenchymatous hepatitis and myocarditis.

There are various explanations of the causes of death in the severe, rapidly fatal cases of burning. It is considered partly a poisoning, partly a derangement in the circulation, partly a paralysis of the nerves as a direct result of the burn. According to the toxic theory the burning of the blood in the cutaneous capillaries results in a decomposition of the blood and leads to hemoglo-

binemia, which determines the fatal course; carbon dioxide poisoning results from a diminution of the supply of oxygen taken up by the red blood-corpuscles. In a short time large quantities of hemoglobin circulate freely in the blood; it causes hemoglobinuria, infarcts of hemoglobin in the kidneys, as well as hemorrhages in the spleen and gastric mucous membranes with secondary necrosis (diphtheria) of the latter. In addition to free hemoglobin, the influence of a high degree of heat on the blood apparently gives rise to other toxic bodies (ammonia, pyriden bases, prussic acid, ptomaines). On the other hand, materials formed by the decomposition of white blood-corpuscles have been found. According to the nature of fibrin ferment, these lead to coagulation in the capillaries of the inner organs, followed by severe derangements in the circulation and necrosis, especially in the mucous membranes of the intestines (Silberman, and Welti). The earlier supposition, that death was due to cooling of the body, cannot be maintained; experience has shown that death occurs in man when the burned are permanently placed in warm baths. In many cases a reflex paralysis of the nervous system as a result of excessive irritation of the nervous system and overheating of the blood (44 C.) may be accepted as a cause of sudden death from burning. When the disease exists for some time, death results from a subsequent affection: especially through a septic infection of the blood as the result of resorption of septic, putrid, and toxic materials from the gangrenous areas in the skin, pododerm, and mucous membranes (septicemia).

TREATMENT.—The local treatment of burns is essentially the same as for other wounds; apply an aseptic bandage to fresh wounds as soon as possible to prevent the entrance of infectious material (pus-bacteria). If infection has already taken place, antisepsis must replace asepsis. Nitrate of silver is the best antiseptic for burns. This possesses, in addition to strong disinfecting properties, a protective (eschar of silver) and anesthetic action, it is employed

in the form of a 5–10 per cent aqueous solution, or ointment. Other antiseptic protectives are bismuth salts, oxid of zinc, iodoform in combination with talk or amylum as a dusting powder, etc. Recently, sodium bicarbonate in the form of a dusting powder, as well as picric acid (bandage) has received special recommendation. Among the older remedies may be mentioned so-called lime liniment (linimentum contra combustiones), a mixture of equal portions of lime water and linseed oil. Amputation is indicated in severe burning of the extremities (tail, ears, toe-joint). Injuries due to caustics are treated similar to burns.

3. FREEZING. CONGELATION.

DEGREE.—In freezing, also, one recognizes three degrees: redness, vesicles (congelatio bullosa), and necrosis (congelatio gangrenosa). In contrast to arterial hyperemia of burning of the first degree, the redness of freezing is due to a passive, venous hyperemia. The second degree is an inflammatory reaction of the body in the course of which it leads to the formation of thrombi and severe disturbances in the circulation. The third degree of freezing leads to gangrene, which, in contrast to the dry gangrene of burns, is moist. Death follows extensive freezing as a result of pronounced falling of the body temperature, in other cases, as in burns, fatal septic diseases develop afterwards.

OCCURRENCE.—The domestic animals, especially the horse, are very resistant to cold (winter coat). Usually the injurious influence of cold in winter involves the pododerm, as well as the skin of the coronet, the fetlock, and the pastern. In the Russio-Turkish War (winter 1877–78) the Russian army horses were repeatedly affected with a necrosis of the pododerm similar to that which results from burns (Jewsejenko). The African and Arabian horses seem to be very resistant to cold. According to Cadiot these horses in the Franco-German War (1870–71) were more resistant than the French horses. In the Crimean War (1854–56) the African horses were also able to endure more than the English. Dur-

ing the French Expedition against Algeria in the winter of 1845–46 the African horses remained well, while 25 per cent of the army were frozen to death. Freezing of the scrotum is common among the cattle of Denmark (Bang). Treatment of frozen tissues is the same as that of burns.

LIGHTNING-STROKES.—Large animals are the most frequent sufferers from this affection, this is especially true of cattle at pasture and military horses. In stables, the standing and large animals are especially exposed; for example, among nine horses in a stable only the five that were standing were struck (Ziegenbein). The action of the stroke is variable; sometimes the skin is burned; the soft parts may undergo mechanical rupture; the nervous system may suffer from electric concussion and paralysis; at other times the action ischemical in nature, the red blood-corpuscles are decomposed (lightning-figures caused by the solution and diffusion of hemoglobin in the region). The burns of lightning are either superficial (singeing of the hair), or deep enough to involve the muscle. In a horse that was killed by a lightning-stroke, lines one half cm. broad extended from the inferior surface of the thorax down the inner sides of both anterior limbs as far as the hoofs, the hair on this strip was singed; the subcutem in the same region was strongly infiltrated with blood (Sachs. Jaresbericht. 1894). A horny cicatrix remained in one horse after healing had occurred (Müller). In cows spotted with black the stroke caused circumscribed areas of necrosis in the vicinity of white hairs (Urbain). Experience has shown, that in lightning-paralysis the prognosis is relatively favorable.

Strong electric currents have an action similar to that of lightning. According to Cadiot and Arloing a horse dies only after a long time—several minutes—when exposed to a stream of 500–550 volts. Horses only fall under the influence of 200–400 volts, 100 volts causes slight trembling and collapse at the knees. 550–700 volts, when applied for a short time, does not always result in death. The injuries in the killed horses are partly in the form of circumscribed necrotic wounds, partly the result of falling, rolling, and kicking. The horses that are not killed often present nervous derangements (stupor, weakness), these symptoms usually disappear, occasionally the paralysis is permanent (effusion of blood in the brain). In a horse that came in contact with the wire of an electric lamp the death was lightning-like in its rapidity. Post mortem merely showed large quantities of blood in the lungs and brain, as well as relaxation of the heart-muscle. Another horse became rigid, the muscles quivered for several hours. (Woherling). I observed a case in the horse in which there occurred burning of the second degree.

Sun-stroke and heat-stroke are of no surgical importance.

Sun-stroke is a disease of the brain and medulla oblongata (hyperemia, inflammation, apoplexy, paralysis); heat-stroke is a hyperthermia of the body (overheating, dissolution of the blood, derangement of the heat regulators). For further information see: Friedberger and Fröhner, Special Pathology. 1904, Vol. II).

II. SURGICAL DISEASES OF THE SUBCUTEM.

I. EDEMA.

FORMS.—The term edema indicates a serous infiltration of the subcutaneous connective tissue. According to the causes the following forms of edema are recognized:

a) Inflammatory edema (acute edema of the cellular tissue) is a serous inflammation of the subcutis and cutis; it is, therefore, characterized by rise of temperature, pain, swelling that often develops rapidly, active hyperemia, and pronounced distension of the skin. It is most often found in the horse in the form of so-called "Einschuss" [special form of phlegmon of the hind limbs]. It also occurs as so-called collatereal edema in the vicinity of suppurative inflammatory foci (abscesses). The following are specific forms of inflammatory edema: malignant edema, hemorrhagic edema (anthrax), and blackleg.

b) Stagnation edema (edema of the cellular tissue) occurs through hydropic infiltration of the subcutis after stagnation of the venous blood or lymph. The edematous swelling, therefore, is cool, painless, more or less soft, doughy, and occasionally it retains depressions made with the fingers. In contrast to the clear artrial redness of inflammatory edema, it presents a reddish-blue, cyanotic or livid color. It is found as follows: in old and atonic horses that remain standing for a long time; in pregnant mares and cows, on the abdomen, udder, (edema of the udder), and on the posterior limbs; when the head is held down for a long time; following venous thrombi and phlebitis. Hydremic edema (anasarca) is a special form of stagnation edema due to chronic diseases of the heart, lungs,

liver, kidneys, and diseases of the blood (hydremia); it is found congenitally in the form of so-called water-calves (water-moles, lard or moon-calves).

TREATMENT.—The therapy of the different forms of edema is extremely variable. Treatment of inflammatory edema consists in antisepsis, hydrotherapy, in the application of antiphlogistic remedies, incisions, and injections; stagnation edema is treated with massage, and compression, as well as internally.

2. EMPHYSEMA.

FORMS.—This is an accumulation of air in the subcutaneous connective tissue (pneumatosis); two forms are recognized: traumatic and septic emphysema.

a) Traumatic emphysema occurs, either after the entrance of air through external injuries in the skin, especially in the vicinity of the thorax, throat, and orbital cavity; or after internal injuries to the thoracic walls and lungs (coughs in cattle), after rupture of the esophagus, perforation of the rectum and subcutaneous fractures of the tracheal rings through which air passes from within to without. According to the origin there is recognized an expiration-emphysema (injuries to the trachea and the lungs), and an inspiration-emphysema (aspiration through pumping movements of the thorax, the abdominal walls and the extremities). Under certain influences the accumulation of air under the skin produces the following conditions: the entire back is extensively swollen, the swelling is soft, puffy, crackling, painless, and not accompanied by local heat, it is characterized by a tympanitic tone on percussion; the animal often has a deformed appearance. In general the prognosis of traumatic emphysema is favorable, the air is gradually resorbed through the blood- and lymph-vessels, and the general condition is not usually disturbed. It is a peculiar condition, that inflammation of the subcutaneous connective tissue is usually absent although infectious material must gain entrance with

the air. Treatment consists in massage and compression; frequently this is unnecessary.

b) Septic (gangrenous, spontaneous) emphysema is due to the entrance of gas-forming bacteria into the subcutis, namely, bacillus phlegmonæ emphysematosæ (gas-phlegmon), a gas-forming variety of the bacterium coli, and other micro-organisms. The gas beneath the skin is not composed of air, as in traumatic emphysema, but of putrefactive gases (carbureted hydrogen, sulphureted hydrogen, hydrogen, carbonic acid). In contrast to traumatic emphysema, one finds symptoms of septic inflammation in the skin and subcutem, the general conditions frequently undergo severe changes (septicemia). Blackleg is a specific form of septic emphysema. Following death of a fetus, there develops as a result of decomposition, a subcutaneous, intermuscular, and subserous emphysema (so-called emphysematous fetus or "dunstkalb" vapor-calf).

The treatment of septic emphysema consists in making extensive incisions, removal of the gas, thorough disinfection of the subcutis, as well as eventual amputation of the diseased parts (tail).

TYMPANITIS.—The accumulation of air in body cavities and hollow organs (tympanitis, meteorism) is occasionally of surgical importance; it may follow injuries (pneumothorax following perforating thoracic wounds), and frequently receives operative treatment by means of puncture (tympanitis of the rumen, meteorism of the intestine). Tympanitis of the guttural pouch in foals is a peculiar affection, it is due partly to the entrance of atmospheric air, partly to the development of putrefactive gases. Occasionally one also observes the entrance of air into the abdominal cavity (castration) and into the veins (aspiration of air, see page 4).

III. SURGICAL DISEASES OF THE MUCOUS MEMBRANES.

INFLAMMATION.—Inflammation of the mucous membranes presents the same causes and forms as inflammation of the skin. The following are of special surgical importance: inflammation of the oral mucous membranes (stomatitis),

mucous membranes of the nose (rhinitis), eyes (conjunctivitis), pharynx (pharyngitis), vagina (vaginitis, colpitis), uterus (endometritis), bladder (cystitis), and rectum (proctitis). The following forms of inflammation occur on the mucous membranes named :

1. Erythematous inflammation of the mucous membranes.
2. Catarrhal inflammation of the mucous membranes.
3. Suppurative inflammation of the mucous membranes.
4. Apthous (vesicular, phlyctenular) inflammation.
5. Pustulous inflammation of the mucous membranes.
6. Ulcerative inflammation of the mucous membranes.
7. Croupous (fibrinous, membranous) inflammation of the mucous membranes.
8. Diphtheritic inflammation of the mucous membranes.
9. Phlegmonous inflammation of the mucous membranes.
10. Chronic hyperplastic (granular, verrucose, polypous, cystic, fibrous, follicular, etc.) inflammation of the mucous membranes.

There are also specific inflammations of the mucous membranes (actinomycosis, tuberculosis, glanders, etc.).

Treatment consists in the application of disinfectant, astringent, and protective materials.

IV. SURGICAL DISEASES OF THE PODODERM.

INFLAMMATON.—Inflammation of the pododerm (pododermatitis) presents the same general causes and forms as inflammation of the skin. The following special construction, however, causes variations : the resistance of the protective horn-capsule (hoof, claws) ; failure of the subcutis over the third phalanx, the pododerm occupying the relation of the periosteum ; as well as the exaggerated development of the papillary body and the rete mucosum. The following forms are recognized : superficial and deep; acute and chronic;

serous, suppurative, hemorrhagic (corns), and gangrenous or necrotic; infectious (nail-pricks) and non-infectious or aseptic (laminitis); chronic productive (keratocele, chronic laminitis); as well as circumscribed and diffuse pododermatitis. Because of failure of the subcutis over the third phalanx phlegmonous inflammation occurs only at the coronet (subcoronary phlegmon), in the vicinity of the lateral cartilage (parachondral phlegmon), as well as in the fatty frog (phlegmon of the fatty frog).

APPENDIX.

CONGENITAL MALFORMATIONS OF SURGICAL IMPORTANCE.

GENERAL CONSIDERATIONS.—Aside from mere pathological and anatomical considerations, congenital cases of malformations are of less interest in animals than in man; they are seldom of practical surgical importance, as new-born animals with extensive malformations are usually killed. Still there are a considerable number of congenital malformations in veterinary surgery that are amenable to plastic operations. These are anomalies of the genital and digestive apparatus, eyes, udder, skin, and extremities.

CONGENITAL MALFORMATIONS OF THE GENITAL APPARATUS.—In male animals cryptorchidism, that is, retention of one or both testicles in the abdominal cavity (abdominal cryptorchid), or in the inguinal canal (inguinal cryptorchid) is of greatest practical importance, it most frequently occurs in stallions. With reference to treatment see: Operationslehre by Bayer (Bd. I), [or: "The Castration of Cryptorchid Horses and the Ovariotomy of Troublesome Mares" Hobday[1]]. Failure of one (monorchid), or both testicles (anorchid) is rare, aplasia of one or both testicles is of great importance in the castration of cryptorchids (failure to find the testicles). In exceptional cases, three testicles (tri-

[1]Translator's reference.

orchid) have been observed. An occasional forward dislocation of the testicle, lateral to the penis, is peculiar to dogs; in these animals there also seems to be a predisposition to the development of new formations in the testicles. Congenital fissures are also found in the urethra, the urethra does not form a closed canal opening at the end of the penis, but may have a dorsal opening (epispadia), or a ventral open- into the sheath (hypospadia). It may even form a semi-canal or fistula, opening at the scrotum and perineum. Congenital stenosis of the prepuce (phimosis) sometimes occurs. One frequently observes new-born foals in which there is an opening in the urachus from which urine is constantly dropping (fistula of the urachus); the following have also been described: cystic urachus, ectopia of the bladder as a result of exstrophy, as well as cystic diverticulum after obliteration of the urethra.

In female animals one frequently observes congenital cystic ovaries, congenital closure of the vagina (atresia vaginae), abnormally large development of the hymen, failure or incomplete development of the cervix and uterus, atresia and obliteration of the tubes. There further occurs the formation of hermaphrodites, and apparent hermaphrodites (pseudo-hermaphrodites); I have operated two cases of penis-formation in the vagina of mares. Finally, the formation of rudimentary teats (after-teats) is not uncommon on the scrotum or in its vicinity in bulls, oxen, goats, and rams.

CONGENITAL MALFORMATIONS IN THE DIGESTIVE APPARATUS.—Fissures in the lips and intermaxillary bones (hare-lip, labium leporinum), as well as the palate (cleft palate, wolf's jaw, palatoschisis) are especially observed in puppies and foals as well as cattle. They are seemingly uncommon; in 70,000 cases of diseased dogs I have observed only three cases of cleft palate, and only one case of hair-lip. Congenital shortening of the frenum linguæ has been observed in calves. On the maxillæ, especially in the horse, it frequently occurs that the jaw is abnormally long and projecting (prognathism), or abnormally short and receding

(brachygnathism). These are frequently the cause of so-called pike- and carp-mouth (brachygnathia superior and inferior.) Many anomalies of the teeth are also congenital, especially the disposition to shear-mouth due to narrowness between the rows of teeth in the inferior maxilla; the persistence of the incisor milk-teeth; the occurrence of supernumerary teeth (polyodontia), and canine teeth in mares. The following may also be mentioned: congenital dilitation of the guttural pouches in foals which results in catarrh of the guttural pouches; congenital diverticulum of the esophagus in horses as a result of aberation at the second branchial cleft; congenital hernias in horses, dogs, and swine, which occur in the form of umbilical, inguinal, and perineal hernias. Perineal hernia (hernia perinealis, vesicalis, cystocele) in dogs is due to a protrusion of the recto-vesical excavation; in bitches to a protrusion of the vesico-vaginal excavation. Congenital adhesions of the anus and rectum (atresia ani, atresia recti) have been seen in dogs and swine. The formation of a cloaca (common opening for the rectum and vagina, or bladder and urethra) is frequently congenital in animals. According to Mayr one must differentiate between typical and atypical forms, as well as between cloacas that have, and do not have, fissures in the bladder. The following are the most important of the latter forms: atresia ani simplex, atresia ani vesicalis, (anus vesicalis), atresia urethralis (anus urethralis), atresia ani vaginalis (anus vaginalis), atresia ani with cloaca formation at the vestibule of the vagina (anus vestibularis), as well as anus vulvalis, perinealis, and scrotalis.

CONGENITAL MALFORMATIONS OF THE EYE.—Dermoid of the cornea is a congenital anomaly that is relatively frequent in dogs and calves, it is also seen in horses, sheep, and swine. It consists of a spherical projection of the skin over the cornea at the external angle of the lid; Schindelka has collected statistics on twenty-nine personal and reported cases, nine of these were in cattle, eight in dogs; I have observed and operated fourteen cases in dogs. The following

also, are not rare in dogs and horses: coloboma, that is, congenital fissure and defect of the iris and tapetum; congenital cataract (cataracta congenita), and atrophy of the retina (amaurosis); hyperthrophy of the uveal bodies in the horse; congenital closure of the lids in dogs (atresia palpebrarum congenita); congenital atrophy of the entire eye in dogs and foals (microphthalmus); retention of portions of the pupillary membrane (membrana pupillaris perseverans), as well as the vitreous artery (arteria hyaloidea persistans); finally, atresia of the lachrymal duct at its nasal opening.

CONGENITAL MALFORMATIONS OF THE UDDER.—A congenital smallness of one or more quarters of the udder in comparison with the others (micromazia) is common in cows. Abnormally large development of the milk-glands (macromazia) in male animals, especially in billy-goats, forms an opposite condition. Complete failure of an udder in female animals (aplasia or hypoplasia of the udder) is rare. Congenital closure (atresia) of the openings of the teats, as well as congenital stenosis of the teat-canal (stenosis) is occasionally observed in cows. Cows frequently have an excessive number of teats or after-teats (six instead of four), and dwarf-teats, as well as failure of the fourth teat (congenitally three-teated).

CONGENITAL MALFORMATIONS OF THE SKIN.—In addition to dermoid cysts in the skin and subcutem (occurring in dogs partly in the form of multiple furunculosis), horses, cattle, and goats are frequently affected with a congenital baldness (atrichia, alopecia); the opposite of this condition, excessive growth of hair (hypertrichosis), occurs in horses on the mane and tail. An abnormality that is frequent in fully developed dogs consists in an excessive growth of the claws, especially the after-claws (hyperonychia), with excessive bending (onychogryposis) and growing into the skin (paronychia); according to my experience one per cent of all diseased dogs (540 cases in 70,000) are thus affected. So-called "hornsaule" keratocele of the horn-capsule is an abnormality that is sometimes congenital in the horse.

CONGENITAL MALFORMATIONS OF THE SKELETON AND LIMBS.—Abnormal smallness of the entire skeleton, in part a result of fetal rachitis, is termed dwarf formation (microsomia or acromicria); the opposite condition, excessive development of the limbs, is termed macrosomia, acromegalia, leontiasis ossea, etc. According to Zschokke, restricted growth of the bones that depends on a derangement in the development of the cartilage (achondroplasia) is termed cretinism; that which depends on a deranged ossification is termed rachitis. A surplus number of entire extremities (polymelia) in the domestic animals is less frequently observed than an excessive number of toes and claws (polydactylia); the latter anomally on the anterior feet of swine, as well as on the inner surface of the metacarpus in the horse, has been frequently described and successfully operated. The same is true of adhesions between the claws to form a single claw (syndactylia) in swine. Double formations also occur, especially in calves; I have operated one such case of omopagus parasiticus. Failure of entire extremities (amelia), or single toes (perodactylus) is observed in new-born animals. Finally, one occasionally finds congenital fissure formation in the bones of the skull (cranioschisis), and the vertebral column (spina bifida), the former is occasionally combined with protrusion of the brain (encephalocele), as well as congenital curvature of the vertebral column of the horse and deer (kyphoscoliosis).

CONGENITAL MALFORMATIONS OF THF RESPIRATORY TRACT.—An abnormal enlargement of the bones occasionally causes dyspnea and chronic nasal catarrh in foals. Congenital deformities also occur in the trachea in the form of stenosis, dilitation, and sabre-scabbard-like flattening, it may also roll on its axis or assume the form of a spiral. Goitre is very often congenital in puppies. The following congenital malformations are also of importance: ear-fistula (see page 90) and congenital deafness; I have observed the latter several times, especially in Dalmation dogs, when it was without doubt a hereditary affection.

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